

SECTION C, PART 0

SUBSCRIBER OUTGOING CALL TROUBLE CARD ANALYSIS

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C0 SUBSCRIBER OUTGOING CALL TROUBLE CARD ANALYSIS

The trouble analysis flow charts in the A2 Section of the SFD direct the reader to one of the rounded boxes† at the left of SFD-C002 for subscriber outgoing call trouble record cards.

C0-1 CROSS DETECTION, SEQUENCE FAILURE (SFD-C002)

For either of the double sided trouble cards, there is an MXT designation which is punched if there is a cross detected (X--) or if there is a sequence failure (SQA) of the junctor walking circuit. For the single sided trouble card, there is no MXT punch and it is necessary to scan all the X-- designations and the SQA designation to determine if there is a cross or sequence failure. The reader should proceed through each decision box following Y (yes) if the designation is punched or the statement is true or N (no) if the designation is not punched or the statement is not true. If there is no MXT, cross or sequence failure, the procedure beyond that point is the same for all trouble record cards.

C0-2 TIMING FUNCTIONS

The DTM and CM are designed in such a way that they are timed from seizure until release. Critical functions are timed separately. Understanding the purpose and function of timing circuits will aid the crafts person in understanding the behavior of the marker. General functions of the OAT, WT, SDT/LDT, and TRS timers will be discussed in this section. More detailed description of operations will be discussed in the C1 section.

C0-2.1 OVERALL TIMER (OAT)

The OAT is started when the CM is seized and is stopped when the marker is restored to normal. The timing interval is 9.6 to 15.4 seconds which is greater than the time required on any normal marker usage. This timer guards against failure of any of the other timers. Operation of the timer causes the marker to release without a trouble record but will sound a major alarm.

† Symbols used in flowcharts are described on SFD-A103.

CO-2.2 WORK TIMER (WT)

The WT timer is started when the marker is seized and is stopped when the marker is restored to normal. The timing interval is 450 to 605 milliseconds. This short timer is used to detect troubles as soon as possible in order to quickly release the marker. The WT timer is re-cycled as the call progresses. Operation of the WT causes the marker to take a trouble record before releasing and will be the timer that will most often generate a trouble record.

CO-2.3 SHORT DELAY TIMER (SDT) AND LONG DELAY TIMER (LDT)

The SDT provides a delay of 2.6 to 4.5 seconds on service calls and 1.1 to 1.9 seconds on no-test calls. The LDT provides a delay of 4.6 to 7.5 seconds. Both timers are started by the operation of the seize frame (SF) and seize frame timer (SFT) relays. The operation of the SF stops the WT timer. The SF and SFT relays operate when the marker closes a start lead to select a frame such as the LL, TL, NG, OSC or FAT. The SF and SFT relays also operate on various test calls and on completion of the sender trunk guard test. The SDT timer always functions first unless the trouble recorder is busy. This condition requires the longer timing provided by the LDT. If the SDT should fail, the LDT, which is also timing will function as a back up.

CO-2.4 TRANSFER START TIMER (TRS)

The TRS circuit functions to transfer the marker connector start leads to the alternate marker preference whenever a marker is not seized in approximately one second. If the WT, SDT/LDT are not punched and the TRS is punched, the trouble record indicates that the marker connector could not connect to a CM within the transfer start timing interval and had to transfer its start leads.

CO-3 FALSE CROSS-GROUND TEST (FCG)

The FCG is the next punch designation which must be considered on the flow chart (SFD-C002) and will be discussed briefly at this time. During light traffic conditions the CM operates all hold magnets except the line hold magnet. The FCG relay is connected to the tip and ring leads and will operate if there is a cross between the tip and ring, a false ground on the ring conductor, or a false battery on the tip conductor. The FCG relay will lock operated, stop the marker progress, and force a WT time out.

CO-4 TROUBLE ANALYSIS SEQUENCE CHART (SFD-C003)

Standard sequence charts generally show a sequence of relay operation and release. All relays are shown that relate to a particular function. Trouble record punch indications are shown at the point in the sequence when ground is applied to or removed from the lead to the trouble recorder. Trouble analysis sequence charts omit relays shown on the regular sequence chart, except those relays associated with the trouble record designations (SFD-A103). A designation on the trouble analysis sequence chart without a punch symbol indicates the point in the sequence where that designation would be punched if a trouble record were taken. A designation with a triangle (base down) to its right indicates the point in the sequence after which a designation would not be punched.

CO-4.1 USE OF FLOW CHART AND TROUBLE ANALYSIS SEQUENCE CHART

This section will demonstrate the use of the flow chart (SFD-C002) and the trouble analysis sequence chart (SFD-C003). A crafts person experienced in the use of trouble record cards may find this section basic, but the procedures shown here (even though they may become automatic) are the procedures a qualified crafts person must perform.

Without a selection of trouble record cards to distribute to the reader, certain functions must be assumed. It is assumed that all trunks, trunk links, line links, senders etc. vary. The only equipment that remains the same on all cards is the marker. Following the flow chart (SFD-C002), it is identified that the MXT punch is not indicated. The path to follow is marked N (No). The WT punch is indicated on the trouble record. The path to follow is marked Y (Yes). This procedure continues through the FCG N (No), the TK Y (Yes), the HMS1 Y (Yes), and the DCT1 N (No). The flow chart directs the reader to SFD-C003.

The trouble analysis sequence chart, and all sequence charts, operate from the top of the page to the bottom. To identify the trouble area the reader must start at that point of major failure and back-track to the point where all punch indications (leading to the branch in trouble) are shown.

To demonstrate: Working back from the DCT1, the GT2 is indicated, the DCT is indicated, and the AVK1 is not indicated. (The reader must now follow the path from the AVK1). The RSC is indicated, the SLK2 is not indicated, and the SLK1 is indicated. There are no other paths leading to the SLK2. The problem exists between the SLK1 and SLK2 indications. The page coordinate A7 shows the portion of the trouble analysis sequence chart that is shown in detail on C202. Use of the sequence chart will be shown in paragraph CO-5.

C0-5 SEQUENCE CHARTS

The sequence charts used in the SFD follow standard conventions for sequence charts, except as noted on SFD-A103.

The example in C0-4.1 continues on SFD-C202. The SLK1 punch checks that the SLK relay operates. The SLK relay checks that the SHKA operates. The relays now involved are the SH hold magnet (OSL), ON, CT and LR relays in the sender, D and the S1 in the trunk, and the release of the SLK in the marker. Caution is necessary at this point. When conditions were established for this example, the only equipment that remained unchanged on all cards was the marker. One might assume that relays in the senders, trunks and OSL (and their operations) could be eliminated. However, this is definitely not true. The physical wiring and apparatus can be eliminated, but the lead to operate the S1 relay in the trunk extends to the marker and cannot be eliminated. The S1 relay should be checked to see if it operates, and then the path to the SLK2 checked.

SECTION C, PART 1

ESTABLISHING AN OUTGOING TRUNK CONNECTION

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C ESTABLISHING AN OUTGOING TRUNK CONNECTION

The general sequence of operation of an outgoing trunk connection is as follows:

After dialing is completed, the originating register seizes a completing marker in competition with other originating registers through preference and control circuits. The OR passes line location, class of service, line linkage (dial tone channel used), dialed digits, coin and 2-party information to the marker. The completing marker determines from the translation of the dialed number and other input information received from the originating register, the required route and operates the route relay.

A No. 5 crossbar office is required to supply information to a connecting office when a call is routed through or completed in the connecting office. Senders are used to store the calling information received from the markers and pass digit information to the connecting office. The completing marker determines the type of sender needed and then selects and connects to a sender through the outsender connector. The marker transfers digit, delete, and outputting information to the sender. If AMA is required, additional information will be passed to the sender. The completing marker performs many functions at the same time. Two functions performed at approximately the same time are sender and trunk functions. After the marker selects the trunk, and the F relay operates (part C3), the marker closes a path from the sender to the trunk through the outgoing sender link frame.

While the sender connection is being established (part C2) the completing marker proceeds to select a trunk link frame having an idle trunk of the correct type. It then proceeds to select and connect to a trunk.

Following seizure of the trunk link frame, the line link frame on which the calling line is located is seized. This gives the CM access to, and control of, the calling line select and hold magnets.

Following hold magnet operation, the channel is checked for crosses, continuity and double connections. The sender and trunk information is checked to insure its proper transmission. Connections between a line and a trunk are made by closing the line switch and junctor switch crosspoints on the LL, and the junctor switch and trunk switch crosspoints on the TL. The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch, the trunk on the trunk switch, and on the channel selected.

Upon the successful completion of the double connection test and the ground test, the completing marker transmits an advance signal to the outgoing sender as an indication that the outgoing sender should assume supervision and complete the call. The marker then checks the functions in the outgoing sender, that the linkage is properly set up, and releases. The outgoing sender, having prepared the distant register or sender to accept pulses, awaits a signal from the distant end and then starts outpulsing. After all digits are outpulsed, supervision of the call is turned over to the trunk, and the sender is released.

C1 INPUT TO THE COMPLETING MARKER AND CODE TRANSLATION

After dialing is completed, the originating register seizes a completing marker in competition with other originating registers through preference and control circuits. The OR passes line location, class of service, line linkage (dial tone channel used), dialed digits, coin and 2-party information to the marker. The completing marker determines from the translation of the dialed number and other input information received from the originating register, the required route and operates the route relay.

C1-1 MARKER SEIZURE

Upon operation of a MST relay in the originating register (SFD-C104), start battery is applied to activate a marker start STA lead or a marker start STB lead to start seizure of a completing marker. As will be seen later, the Z relay is operated and released on alternate calls so that the STA and STB start leads are alternately activated on successive calls. Each register is given preference to one completing marker for an STA start and to another for an STB start by cross-connecting MSA and MSB punchings on SFD-C104 to appropriate MS- punchings on SFD-C105.

C1-1.1 MARKER CONNECTOR RELAY CHAIN CIRCUITS (SFD-C105)

Three chain circuits are used in selecting a completing marker and closing the connector relays between the register and the marker selected. The description of these chains which follows is typical of chains in other connectors.

C1-1.2 CB- (MARKER CONNECTOR BUSY) RELAY CHAIN

An operated CB- relay indicates that the associated marker is busy to the connector. A CB- relay operated for a preferred marker advances the start lead to the next preferred marker. If the CB- relay for that marker is also operated, the start lead is advanced to the next preferred marker, etc.

C1-1.3 MS- (MARKER START OR PREFERENCE) RELAY OPERATE CHAIN

In periods of very light traffic (and assuming no markers busy) MS-relay operation is straightforward. A start signal from a register operates the MS- relay associated with the MS- terminal to which the start lead is cross-connected.

In periods of heavy traffic one or more markers may be busy and two or more registers may initiate marker requests either simultaneously or in rapid succession.

Assume that the first and last registers (SFD-C105) initiate simultaneous marker requests. Also assume that both start leads are connected to MS0 (that is both prefer marker 0). The MS0 relay associated with each of the two registers will operate through the MSK cross-connection to ground in the marker. An early make contact on the MS0 relay for the first register will provide locking ground for that MS0 relay before the break contact on the MS0 relay for the last register opens the MSK ground. Thus, both relays will operate and lock.

If, however, the last register initiated a request for a marker slightly ahead of the first register, the MS0 relay for the first register could not operate. On the other hand, if the first register initiated a marker request first, a subsequent request by the last register could operate the MS0 relay for that frame.

C1-1.4 MS- RELAY WORK CHAIN

Since it is possible to operate two or more MS- relays at the same time, the work chain determines which MS- relay does the work. Ground for the work chain originates in the marker at the MAK cross-connection. It should be noted that the work chain proceeds through contacts of each MS0 relay in a reverse direction to the preference MSK chain. Contacts on the MS0 relay for the first register are, therefore, enabled to operate connector relays MA- through ME- whether or not any other MS0 relay is operated.

Upon operation of the originating register marker connector relays MA-through ME-, the MCB- relays of the selected marker are operated over the MB lead (SFD-C106). The MCB- relays operate CBO relays in every connector having access to that marker (SFD-C105). It should be noted that an operated MA- connector relay contact bridges the break contact of the CBO relay in the start path so that the operated MS0 relay is not released when the associated CBO relay operates.

If two or more MS0 relays had operated for different registers, the start lead for each of those which failed to get a marker would be advanced to the next preferred marker by operated CBO relays. If, however, no other markers were available, no new MS- relay would operate until some marker became available, at which time one or more MS- relays for that marker would operate. This would continue until all registers had been served.

During periods of heavy traffic when all completing markers become busy, a traffic control circuit gates requests by registers for CMs as described in a subsequent section, so that all registers requesting service are served once before any register is served a second time. Relay MS- in operating releases the marker connector check relays MAK, MCK, and MSK (SFD-C105). The release of any one of these relays operates relay TM (SFD-C108) which starts marker timing.

C1-1.5 W AND Z RELAY CONTROL FOR TRANSFERRING START LEADS (SFD-C104)

If only one start lead is provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. If this marker is in trouble, all calls from that register might be blocked. To prevent this and also to reduce the adverse effects of other circuit failures, two start leads are provided in each marker connector. By alternating the use of these start leads, two markers serve alternately as first choice markers, thereby providing more even wear on the marker connectors. This transfer is accomplished with a W and Z relay combination. The operation and release of relay Z provides the necessary transfer.

In the following description, assume that relay TRS (transfer start) is normal.

The W and Z relay combination (SFD-C104) operates as follows:

(a) FIRST CONNECTOR USAGE

- (1) Marker seizure - Assume that relays MA- through ME- of the originating register marker connector and W and Z of the preference control circuit are normal. Lead STA has continuity through the break contact of relay Z and lead STB is open. A marker is seized by operation of relay MS- via the MSA to MS cross-connection. Relay MS- causes the operation of relays MA- through ME-. Relay MD- operates relay MK in the preference control circuit (SFD-C104), which in turn operates relay W which locks.
- (2) Connector release - When the connector releases, release of the MD- relay releases relay MK which causes the Z relay to operate through the operated W. Relay Z locks operated from the ground of relay W which remains operated but the locking ground for W is now through the operated Z to the released MK. The operation of relay Z opens start lead STA and closes STB making it available for future usage.

(b) SECOND CONNECTOR USAGE

- (1) Marker Seizure - At this time relays MA- through ME- are normal. Relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB to the MS- cross-connections. Relay MS- causes relays MA- through ME- to operate. The operation of relay MK, this time, opens the locking path of the W allowing it to release.
- (2) Connector Release - The release of relay MK when the connector releases removes the Z relay holding ground, allowing it to release. Relay W remains released. The release of relay Z opens lead STB and closes lead STA making it available for the next connector usage. For subsequent usages the actions described above repeat.

C1-2 TIMING FUNCTIONS IN THE PREFERENCE CONTROL CIRCUIT

Timing circuits in the preference control circuit control marker seizure and once the marker is seized, time its overall function. These timing circuits are discussed below.

C1-2.1 TRANSFER START TIMER (SFD-C108)

The transfer start timer allows an interval of 0.6 to 1.25 seconds for the OR to connect to a CM (unless all CMs are busy). If the connection is not established in this time interval, the preference control circuit transfers the start leads and gives a TRS signal to the CM to cause a trouble record to be taken showing that there was a transfer start condition.

The operation of the MST relay in the OR operates the TM relay (SFD-C108). The TM relay operates the TM1 and also closes through the IM lead from the master traffic control to operate the IM relay. The IM lead will normally be grounded unless all CMs are busy, in which case operation of the IM relay is delayed until a CM becomes idle. The IM relay starts the TRS timer.

The TRS timer continues to time until the connector relays MA- through ME- operate. The check that the connector relays have operated, the MA-relay connects ground to the CKG lead to operate CKG1,2 relays. The CKG1,2 relay connects ground to the MTFC as a check that the connector relays operate. The MC- relay grounds the TC and TC1 leads to operate the TC and TC1 relays in the preference control circuit. The operated TC and TC1 relays in the PC opens the path to the IM relay (SFD-C108) which stops and recycles the TRS timer.

If a marker is not seized in approximately one second, (providing markers are available as indicated by ground on the IM lead), the TRS tube will fire and operate the TRS relay. The TRS relay opens the start lead in use, closes the alternate one (SFD-C104), releases the TM relay, in the preference control and holds the TMI relay operated (SFD-C108). The TM relay is released to open the signal leads CWA and TCA (SFD-C108) to the traffic control circuit to prevent its timing out because of a marker connector trouble. The TM relay also releases the IM relay to recycle the timer (SFD-C108). The TMI relay is held operated to continue the overall timing before a marker is seized. The TRS relay locks operated through the TMI relay. When a marker is obtained over the new start lead, the TMI relay releases upon operation of the MK relay. The TRS relay remains operated over its locking contacts under control of the MK relay. The TRS relay transmits to the marker the fact that the transfer has taken place. This information is passed over the TRS lead. The marker causes a trouble record to be taken showing a TRS punch and indicating the OR which encountered the TRS failure. Upon release of the marker, the MK relay, in releasing, will release the TRS relay.

C1-2.2 OVERALL TIMER (SFD-C107)

An overall timing circuit is provided which sounds the major alarm if an OR calling for a marker has not been connected to one within 4.6 to 10 seconds. It functions as follows: Upon the start of a call, operation of a relay operated the TM relay at the same time that battery is connected to the start leads for marker seizure. The TM relay operates the TMI relay which starts the overall TM timer (SFD-C108).

For normal operation, a marker is seized before the timing interval has elapsed. This is indicated by the operation of the MK relay from the operated marker multi-contact connector relays in the originating register marker connector circuit. The MK relay releases the TM and TMI relays. During the releasing time of the TM and TMI relays, the TM tube timer circuit is recycled by discharging the A capacitor through the C resistance. The TMI relay normal with the MK relay operated restarts the A capacitor charging circuit to time the release by the marker. If the marker releases the connector within the timing interval, the TM tube will not break down. However, should the marker exceed this time interval because of some trouble condition or should the marker connector relays remain operated due to a trouble, the TM tube will fire, operating the CA relay which brings in the major alarm and causes the ORMC- lamp at the JLK to remain lighted. This lamp normally flashes on each time the MK relay operates as an in-use indication for the ORMC. When it remains steadily lighted, it serves as an ORMC alarm indication.

The MK relay releases at the end of the call upon release of the originating register marker connector circuit multicontact relays and discharges the A capacitor to recycle the TM timer for the next call.

C1-2.3 WORK TIMER

When a marker is seized, the released MAK, MCK or MSK relay operates relay TM, timing marker off normal, which operates relay TMS, timing start. Relay TMS places a ground on one side of capacitor WT and opens the path through resistor WT3 which was shunting it. The WT capacitor becomes charged from the +130 volts battery placed on the side of it through resistor WT1. This causes the voltage on the control anode, terminal 1, of the WT tube to gradually increase through resistor WT2. If after .450 to .605 seconds the marker does not complete the particular function that is being timed, the control anode of the WT tube is increased to positive 72 volts, thereby causing the WT tube to conduct. When the tube conducts, it operates relay WT, work timer. Release of the TMS relay causes the WT capacitor to discharge through the WTS resistor. Because many marker usages exceed the short time interval provided, this timer is recycled as the call progresses. Operation of the WT timer causes the marker to take a trouble record before releasing. The SDT, LDT, TRTR, OAT and HTT tube timing circuits work basically the same as the WT tube timing circuit.

C1-3 INFORMATION FROM THE ORMC TO THE CM

When the ORMC- marker part multicontact relays (MA-ME) operate, information leads from the OR are extended to the CM. The information that passes to the CM is as follows:

<u>Lead Designation (From ORMC)</u>	<u>SFD Location</u>	<u>Lead Description</u>
A2/5 - L2/5 M7	C-115	Called numbers
LT, LT1 11,	C-110	Translator to be used for translating area or office code.
CTA 2/5, CU 2/5, CRU 2/5, CGA, CGB, TP, RP	C-113	Subdivisions of cus- tomer class of service and treatment.
MF, D	C-111	Type of customer sig- naling, TOUCH-TONE® or dial.
FAC, OR	C-110	Type of call.

<u>Lead Designation</u> <u>(From ORMC)</u>	<u>SFD Location</u>	<u>Lead Description</u>
FT 2/4, FU 2/5, VG 2/6, HG 2/5, VF 1/5, LL 2/5	C-114, C-111	Line equipment location on line link frame.
MRL, RL, BT, TRL, BRL	C-107	Release signals to register for normal busy, and trouble releases.
PS, PD, CR, SCN, PK, SCK, CNR	C-112	Trouble and check signals from register, permanent signal partial dial, coin return, stuck coin, permanent signal-partial dial check, stuck coin-coin return check.
CKG, TM, MB	C-108	Marker seizure from register.
OBS, NOB	C-111	Service observing or no service observing.
TRK, TR2, TRS	C-108	First and second trial, and start lead transfer signals.

The leads listed in the table above will operate related relays except the following:

- (a) A 2/5 - C 2/5 will operate the AC 2/5 - CC 2/5 relays.
- (b) D 2/5 - M 2/5 will extend through make contacts in the marker when the sender is seized and operate relays in the sender.
- (c) The LT1 lead will operate the ELT relay.
- (d) The CTA 2/5 leads will operate the CT 2/5 relays.
- (e) The CU 2/5 leads will operate the CUA 2/5 relays.
- (f) The 11 lead will operate the 11X relay.
- (g) The D lead will operate the DP relay.

C1-4 GROUNDING A CODE POINT

The marker action for any call depends on directing information received from the register. The information required may come from a direct signal or from the translation of an office or area code. Marker translation consists of changing the code digit information into a single indication which is called a code point. Thus, the result of translation is to "mark a code point." Each digit is received on a 2/5 code basis. The called number information can be in any of various numbering plans, but in general, the number consists of the following:

- (a) 4 numerical digits
- (b) 1, 2, or 3 digit office code plus 4 numerical digits
- (c) A 3 digit area code, 3 digit office code and 4 numerical digits.

The examples used in this SCD will be 3 digit office code plus 4 numerical digits. Grounding or marking a code point requires three separate functions for a 3 digit office code, the A digit translator, the B digit translator and the C digit translator. The example will illustrate how to ground code point C983.

C1-4.1 A DIGIT TRANSLATOR (SFD-C120)

The ground to operate the A digit translator originates on SFD-C120. Ground through XTA 5B (break) through CKG2 6M (make) through OR 12M through FAC 12B, through SCN 8B, through SCK 8M, through CR 7B, through PS 4B, through PD 6B, through PK 6M, through PK 4M, through SCN 6B, through OR 11M, through AC-0 4B, through AC-1 4B, through AC-2 4M, through AC-4 6B, through AC-7 6M, through AC-2 5M, through AC-7 2M through LT 10M to the cross-connect punching LTA 9. This punching is cross connected to ATW 9 and operates the A digit translator relay, AT 9.

C1-4.2 B DIGIT TRANSLATOR (SFD-C121)

The ground to operate the B digit translator originates on SFD-C121. Ground through CKG2 8M, BC-0 4B, BC-1 4M, BC-2 6B, BC-4 6B, BC-7 6M, BC-1 5M, BC-7 5M, and AT-9 9M to ground punching AT98. The same ground extends through BC-1 10M and BC-7 10M to operate the B258 relay. The cross-connect punching AT98 is cross-connected to BT9T (see table SFD-C121) to operate the BT9T relay.

C1-4.3 C DIGIT TRANSLATOR (SFD-C122)

The ground to operate the C digit translator originates on C122. Ground through CKG2 7M, CC-0 4B, CG-1 4M, CC-2 6M, CC-4 8B, CC-7 8B, CC-1 3M, CC-2 3M, B258 4M and BT9T 23M to ground code point C983.

C1-5 SERVICE TREATMENT, PREROUTE RELAY AND ROUTE SERIES RELAY OPERATION

A route is not necessarily identified by the grounded code point alone, but usually requires a combination of code point and class of service, service treatment, and may require preroute and route series relay operation.

C1-5.1 S-RELAY OPERATION, SC-, USC- AND S- CROSS-CONNECTIONS

As previously described, the translation of a code grounds a code point. Customers and trunks are assigned classes to aid in determining the route a call will use. The process of combining code point and class to identify a route is called service treatment. This service treatment is accomplished by using S-, screening relays and their associated cross-connects. The S-relay contacts are wired to USC- and S- punchings (SFD-C127-134). Cross-connections between S-punchings and route relays control the selection of a route when service treatment is required. All classes, customer and trunk, (trunk class will be discussed in detail in SFD Section D) are served by a common group of service treatment relays. The marker has capacity for a maximum of 180 relays; 60 of them are located on the translator and code treatment frame, 60 are located on the supplementary service treatment frame, and 60 are located on the auxiliary supplementary service treatment frame. These relays are furnished on single mounting plate units. Each unit has 12 relays each having 12 make contacts and two D type terminal strips. The control winding terminal of each relay is wired to an SW- punching on terminal strip TA. The SW- punching number will be the same as the S-relay number. The 12 fixed contacts on each relay are wired in multiple to three other relays on the same unit and the common multiple is connected to 12 punchings designated USCO-11 on the terminal strip. The 12 make contacts of each relay are wired to 12 individual service treatment punchings SO-11 on terminal strip TM. The S- relay contacts count 1-12 so that the USCO punching is wired to S- relay 1 fixed. The SO punching is wired to S- relay 1 make. The wiring pattern on each mounting plate unit gives three sets of four relays and each set of relays has 12 USC-punchings on the unit terminal strip.

The marker is arranged for 120 service common SC- punchings, which appear on cross-connection terminal strips on the translation and code treatment frame. Sets of 12 SC- points; SCO-11, SC12-23, etc. are connected by means of loose wire on the rear of the frame to USC-points on the S-relay unit terminal strips. The loose wire is assigned on a job basis to multiple the required number of S- relays, in groups of four relays, to each set of 12 SC- points. In offices with relatively few classes, it is probably desirable to order one S- relay per class. In offices with more complex service treatment patterns, substantial reductions in the number of relays are often possible by use of group sort treatments. The "sort" arrangement in the marker basically provides either two or four separate output points (SWC- punchings for each class of service).

In other words, one class of service may operate up to four S- relays (SFD-C126A0). The SC- points for which treatments are variable from class to class, with no particular pattern must be handled on an individual treatment basis; one S- relay furnished per class of service, per 12 SC- points. The SC- points for which two or more classes of service are always treated alike may be served on a group sort basis, one relay may represent several classes for this group of SC- points.

C1-5.2 PREROUTE RELAYS

A preroute relay is considered an auxiliary to the route relay and provides extra contacts, not available on the route relay, for other functions. Examples of preroute relays and their functions are LPA and LPB, DR0-3, and OPSO and 1 as explained below.

C1-5.2.1 LPA or LPB Local Physical Office A or B Relays (SFD-C128)

The SFD-C128 shows typical route relay operations. One example uses preroute relays LPA and LPB, local physical office A and B. This informs the marker that the call terminates within the marker group. When the code point C765 or 766 is grounded the local completion relays LPA or LPB operates. This operates the desired route relay on 1A0 calls. 1A0 calls will be covered later in SFD- E section.

C1-5.2.2 Diverted or Denied Route Relays (SFD-C129, 130)

The DR0-7 (diverted route), relays may be arranged to deny service to certain classes of customers (such as PBX lines not allowed to place toll calls). On diverted service the S- points connect to a DR0-7 relay (SFD-C129) which prevents the R- route relay from operating because of the high resistance winding of the DR- relays but the DR- relay will operate. The operation of the DR- relay acts as a preroute to operate the desired route relay for the route assigned to the customer who is being denied access to the route requested.

C1-5.2.3 Operator Routes (SFD-C130)

The OPSO and 1 relays are preroute relays and are provided on operator routes when the marker is required to pass a class signal to the trunk over the "TC" lead. The signal usually results in a tone signal to the operator which indicates the class of the calling customer. There are other preroute relays not covered by this SCD but can be found in CD-26002-01 Section II.

C1-5.3 ROUTE SERIES

The route relay does not furnish the information as to what charge condition is to be met in the trunk, the call is free (flat rate), or a message register must be operated, etc. This is accomplished by inserting a route series relay between the route relay and battery. These route series relays (NCNC, MBS-) appear on the translator and code treatment frame.

C1-6 TYPICAL ROUTE RELAY OPERATIONS

The SFD-C128-C134 shows a few typical route relay operations. The purpose is to give the crafts person an overview of screening and route relay operation. The SD-26002-01 Section D Note 400 series illustrates many more typicals. The examples above may be used in the established format by the operating company or may vary depending on the complexity of their routes. In all cases, the office cross-connect records should be examined to determine the local assignments. Two examples of route relay operation will be demonstrated.

Example #1, assume a call originates from the 765 office (office A) to the 253 office in the same area code and the class of service is 1 party flat rate (1F). The operation of the route and route series relays is as follows. The service treatment relay (S28) operates per the table on SFD-C127. Ground on code point, C253 (SFD-C129), extends from C253 to the SC12 punching, to the USCO punching, through the S28 1M, to the S28 punching, to the SG13 punching, to the RC30 punching, through the route relay R30, to the R30 punching, to the NN punching through the non-charge-non-coin (NCNC) relay, to the route series battery. This operates the route and route series relays.

Example #2, assume a call originates from the 766 office (office B) to the 222 office in the same local area code and the subscriber class of service is 2-party message rate (2MR), the operation of the route and route series relays is as follows. The service treatment relay (S38) operates per the table on SFD-C128. Ground on code point C222 (SFD-C129) extends from C222 to the RC32 punching, through the route relay, R32, to the R32 punching, to the SC14 punching, to the USC2 punching, through the S38 3M, to the S38 punching, to the MBS1 punching, through the message billing series (MBS1) relay to the route series battery to operate the R32 and MBS1 relays.

C1-7 INFORMATION TRANSMITTED THROUGH CONTACTS OF THE ROUTE RELAYS, R--- AND FC--- (SFD-C119)

The route relay controls the marker functions required for trunks and senders. Service cross-connects in the CM and TL permit the information controlled by a route relay to vary, depending on the office requirements. The R--- (route relay), provides 30 make contacts. The FC--- (frame test lead cut-in), relay is an additional route relay required in offices having more than 20 trunk link frames. When the FC--- relay is provided it operates in parallel with the route relay. Functionally, the FC--- relay may be considered as part of the route relay. The FC--- relay provides 12 make contacts. The assignment of contacts for the R and FC relays is shown in table A on the next page.

TABLE A

ROUTE RELAY CONTACT ASSIGNMENT

RELAY	CONTACT	TERMINAL DESIGNATION	RELAY	CONTACT	TERMINAL DESIGNATION
R000-R399	00	TB-	R000-R399	33	FTC 8
R000-R399	10	OS-	R000-R399	43	FTC 13
R000-R399	20	DL-	R000-R399	53	FTC 18
R000-R399	30	FTC 5	R000-R399	04	OF-
R000-R399	40	FTC 10	R000-R399	14	FTC 1
R000-R399	50	FTC 15	R000-R399	24	FTC 4
R000-R399	01	TG-	R000-R399	34	FTC 9
R000-R399	11	CL-	R000-R399	44	FTC 14
R000-R399	21	CP-	R000-R399	54	FTC 19
R000-R399	31	FTC 6	FC000-FC399	1	FTC 20
R000-R399	41	FTC 11	FC000-FC399	2	FTC 21
R000-R399	51	FTC 16	FC000-FC399	3	FTC 22
R000-R399	02	RA-	FC000-FC399	4	FTC 23
R000-R399	12	CR-	FC000-FC399	5	FTC 24
R000-R399	22	FTC 2	FC000-FC399	6	FTC 25
R000-R399	32	FTC 7	FC000-FC399	7	FTC 26
R000-R399	42	FTC 12	FC000-FC399	8	FTC 27
R000-R399	52	FTC 17	FC000-FC399	9	FTC 28
R000-R399	03	PC-	FC000-FC399	10	FTC 29
R000-R399	13	FTC 0	FC000-FC399	11	FCK 3
R000-R399	23	FTC 3	FC000-FC399	12	Operate XFC REL.

**C1-8 TABLE B, TERMINAL STRIP LOCATION FOR ROUTE RELAY AND SERVICE
TREATMENT CROSS-CONNECTIONS USED IN THE SFD-C SECTION**

The location for the route relay and service treatment cross-connects may be found in SD-26002-01 Section D, cross-connect punching index. The route relay cross-connections used in the SFD-C section are listed in the following table (TABLE B) for easy reference.

TABLE B

TERMINAL DESIGNATION	LOCATION			FUNCTIONAL MEANING
	TERMINAL BLOCK	SECTION	FRAME	
AMA	CF	3	CE	AMA-2W
APR	TF	1	TR	Office "A" Physical Route
BL	TN	1	TR	Busy Line
BPR	TF	1	TR	Office "B" Physical Route
C000-C499	TK	1,2,3	TR	3 Digit Code Points
C500-999	TH	2,3,4	TR	3 Digit Code Point
CA	TE, PA LD	3	TR, ARM RM	Catch-All Auxiliary
CC	PA	3	ARM	Coin Collector
CC	TC	2&4	TR	Coin Collector
CC	LD, TN	2,3,4	RM, TR	Coin Collector
CG00-59	TF, TJ LA	1-4	TR, RM	Code Grouping
CG60-119	LA, TJ	2,1-4	RM T&CT	Code Grouping
CLC	TD	4	TR	Class Control
CNS	TN	1	TR	Coin Signal
DR-	TL	1	TR	Diverted Route
ETA-	TK	4	TR	Extra Translation "A" Code Points

TABLE B (Cont)

TERMINAL DESIGNATION	TERMINAL BLOCK	LOCATION		FUNCTIONAL MEANING
		SECTION	FRAME	
FVD-	TK	4	TR	5 Digit Code Point
HTR	TN	2	TR	Heavy Traffic
LR	TE	2	TR	Route Advance
MBS-	TC, TN	1, 3	TR	Message Billing Series
NC	TC, TN	1, 3	TR	Non Charge Coin
NN	TC, TN	1, 3	TR	Non Charge Non Coin
NS1	RB	2	RR	No Sender Intraoffice
OP-	TF	2	TR	Operator Code Point
OSC-	CF	3	CE	Outsender Connector
	*			
OV	TD, TF	2, 1	TR	Overflow
PB	TE, LD	2, 3	TR, RM	Paths Busy
PC	TD	3, 4	TR	Preroute Charge
PCS-	TL, STB	1	TR, SST	Peg Count Service
PD	TF	4	TR	Partial Dial
PM	PA, LD,	3, 3,	ARM, RM,	Permanent Signal Coin
	TN	1	TR	
PN	PA, LD,	3, 3,	ARM, RM,	Permanent Signal Non-Coin
	TN	1	TR	
PP	PA, LD,	3, 3	ARM, RM,	Permanent Signal PBX
	TN	1	TR	
PS	TF	4	TR	Permanent Signal
R---	TD	1, 2,	TR	Route Relay R-Terminal
		3, 4		

* Other Locations

TABLE B (Cont)

TERMINAL DESIGNATION	TERMINAL BLOCK	LOCATION		FUNCTIONAL MEANING
		SECTION	FRAME	
RA---	RA, RC, RD	2	RR	Route Advance
RAG--	TF, LA, PC	2, 4, 4	TR, RM ARM	Route Advance Grouping
RB	PA, LO RC, TN	3, 3, (2, 4) (2, 4)	ARM, RM TR	Route Battery
RC---	LH, TG TL	(1-4) (2-3)	RM, TR	Route Relay RC - Terminal
RGT	TD	4	TR	Ringer Test
RGTA	TF	1	TR	Ringer Test per Route
ROA	TE, TJ, TN	3, 1, (2, 4)	TR	Reorder Auxiliary
RPA/RPB	TJ	1	TR	Ringer Test Off "A/B" Physical
RR-	TF	4	TR	Diverted Route
RV	TD	4	TR	Reverting
S--	TM, STB	(1, 2, 3, 4) (1, 2, 3, 4)	TR, SS	Service Screening
SC--	TE, TJ *	(1, 2, 3) 1	TR	Service Control
SCG	TD	4	TR	Service Control Ground
SCN	TF	4	TR	Stuck Coin
SG--	TF, TN *	1-4	TR	Service Screen Group
TAV	TF	4	TR	Tandem Vacant Code

* Other Locations

TABLE B (Cont)

TERMINAL DESIGNATION	TERMINAL BLOCK	LOCATION		FUNCTIONAL MEANING
		SECTION	FRAME	
TN	LD, TC, TN *	1, 3	RM, TR	Talking Charge Noncoin
TO	TC, TN *	(2, 4) (2, 4)	TR	Intertoll Route Series
TOV	TF	4	TR	Toll Vacant Code
USC-	TS on Service Treatment Unit		TR	Unit Terminal Punchings for SC-
VCG	TJ, TE	(3-5), 3	TR	Vacant Code Grouping
VC-HB	TP	4	TR	Vacant Code Hundreds Intercept - Block
VC-I				Vacant Code Vacant Intercept - Code
VC-ST				Vacant Code Intercept - Start
VC-TB				Vacant Code Tens Intercept - Block
VC-U				Vacant Code Intercept - Units

* Other Locations

C1-9 OPERATION OF THE CKG1,2; GC, GCA, LLC1,2; ONX, TLC1,2 AND BX
RELAYS

To provide a large number of off normal grounds and battery potentials to the marker circuit and to interconnect certain functional units, the CKG1,2; LLC1,2; and TLC1,2 relays will be operated.

The operation of the ORMC MA- through ME- relays will extend ground to the CKG lead and will operate the CKG1,2,4,5,6 relays in the marker (SFD-C108). The CKG- relays provide off normal grounds.

The CKG2 relay in operating will operate the BX relay (SFD-C109). The CKG1 relay in operating will operate the ONX relay (SFD-C108). The BX relay provides bias for some of the cross-detecting relays, while the ONX relay provides means for testing for crosses on the select magnet leads.

The operation of the CKG2 relay will operate the TLC1,2 relays (SFD-C306). The TLC1,2 relays provide battery potential for operating the trunk link connector cut-through relays and other miscellaneous off-normal ground and battery functions.

The operation of the CKG4 relay will operate the LLC1,2 relays (SFD-C307). The LLC1,2 relays provide battery potential for seizing the line link frame and operating the line link connector cut-through relays. The LLC1,2 relays also provide other miscellaneous grounds and batteries.

The operation of the LLC1 relay will operate the GC or, if provided, GCA relays which provide junctor group control functions (SFD-C525).

C1-10 ROUTE RELAY FUNCTIONS (SFD-C119)

When the route relay operates, ground is extended through the route relay to operate information relays that will be used to complete the call. They are FTC 0-29, TB 0-5 (TB0-9), TG 0-9, CR 0-4, CP 0-10, DL 0-6 and CL 0-9.

C1-10.1 FTC 0-29 RELAY OPERATIONS (SFD-C304)

When the route relay operates, the marker determines which trunk link frame has at least one usable trunk available by closing ground to operate a FTC-, frame test common, relay.

C1-10.2 TB0-5 (SD-26032-01) OR TB0-9 (SD-27879-01), TGO-9 AND TGP OR TGS

Trunks are located in terms of trunk block and trunk group. When the route relay operates, ground is extended through its make contact to operate the TB0-5 (TB0-9) trunk block; TGO-9, trunk group and TGP, trunk group primary or TGS, trunk group secondary, relays. The TB- relay in the marker operates the TB- relay in the TL to cut through all BT00-19 leads associated with the trunk block. The TG- relay, with the TGP or TGS, cuts through a TG- lead to test all idle trunks of a particular route.

C1-10.3 CR 0-4, COMPENSATING RESISTANCE, RELAYS

The CR 0-4, compensating resistance, relays may be required when a PC1, panel call indicator, (Manual Office) or RP, revertive pulse, senders are required. Also, the CR 0-4 and CRP or CRS relays will operate if it is desirable to outpulse one arbitrary digit.

C1-10.4 CL 0-8, CLASS, RELAY OPERATION

The operation of the CL 0-8, class, relays determines the class information which is used to indicate a variety of control signals to the senders: for type of trunk and type of call information for CAMA, with MF senders; number of digits in the office code with revertive senders; type of trunk, type of pulsing and pulse speed, with dial pulse senders.

C1-10.5 CP 0-9, CODE PATTERN, RELAY OPERATION

The CP 0-9, code pattern, information is used on AMA calls to indicate the structure of the called number. It tells the sender how many digits are in the office code and whether the numerals consist of 4 or 5 digits (party letters).

C1-11 MONITORING ORIGINATING REGISTERS

In monitoring, the AMRST (automatic monitor register sender and test) circuit monitors registers (and senders) at random and independently records the number pulsed into a register. This number is compared with the number the register sends to the marker. If these numbers do not agree, a trouble card is perforated identifying the circuit in trouble and giving other information relative to the trouble. If the numbers agree, the monitor releases. In either case, the service call is not affected by the action of the ARMST.

C1-11.1 PULSE END AND CONNECTION TO A MARKER

When the register recognizes that pulsing is completed, the register connects to a marker through the marker connector. At the same time, the monitor connects to the marker through the MTFC to obtain the information transmitted from the OR to CM.

When the OR starts to select a CM, ground is removed from the MST lead causing the RPE1, register pulse end one, relay to operate. The RPE1 relay breaks the pulse circuit from the P, pulse repeater, relay to the L, line, relay to prevent the monitor from registering any further pulses. To prevent the monitor from receiving a false pulse, ground is received on the MST1, marker start from OR, at the start of any operations. This ground operates the EMP, end monitor pulse, relay to break

the monitor pulsing circuit. The RPE1 relay operates the PEA, pulse end auxiliary, relay. The PEA relay opens the MST lead, recycles and changes the monitor timing interval. Ground from the PEA is closed through break contacts of the PH, pulse help, relay to operate the PE, pulse end, relay. The operated PE relay closes a path to operate the A7-M7 register relay of the digit beyond the last pulsed digit.

When the marker connector connects the register to a marker, a circuit is established from the MM, marker selected on monitor calls, relay to operate the MON, monitor, relay in the marker to prepare it for a monitored call. The MM and MON relays operate in series. The MM relay operation completes the circuit to operate the monitor preference relay in the master test frame connector.

Assuming that the MTFC is not busy, battery on the TRST lead operates the monitor preference relay in the MTFC which operates the CI, cut in, relay. The CI relay closes ground to the ON lead to operate the ON, off-normal, relay. Relay CI also operates the CT1, cut in, relay which operates the multicontact relays MCA and MCB. The MCA and MCB relays connect groups of leads from the monitor to the MTFC. Relay CI also connects ground to the MKB lead to the marker. This lead is multiplied to all markers but is effective only in the marker with an operated MON relay. The monitor is now connected to the marker through the MTFC and has registered information necessary for monitoring purposes.

When the MTFC is busy, it operates the TRB, master test frame connector busy, relay of the monitor which opens the TRST lead to prevent seizure of the MTFC until it is fully released. If the TRB is operated when the MM operates, a circuit is closed to operate the NRR, no record release, relay. The NRR relay opens the TRST lead to prevent any further attempt to seize the MTFC. The monitor does not attempt to check the number under this condition but releases after the register and marker release.

C1-11.2 REGISTRATION OF INFORMATION FROM THE MARKER

The physical location of the calling line is recorded through the MCA relay. This information is stored for use if a trouble record is made. The relays used to store this information are VG 2/6, vertical group; VF 1/5, vertical file; HG 2/5, horizontal group; FU 2/5, line link frame units; FT 1/4, line link frame tens.

The number of the marker handling the call is recorded through the MCA relay. One of the MO-9, marker units number, relays operates for the units number and if there are more than 10 markers one of the MKTO-1, marker tens, relays operate for the tens number.

The called number information passed from the register to the marker is closed through the MCB relay. Five leads for each of eleven digits are

provided and an M7 lead to register a 7 beyond the last digit. KA 2/5 - KS 2/5, check A-L digits, relays operate in each digit position to correspond to the information passed from the register to the marker. The operated relays lock and control the number checking path in combination with the register relays previously operated by the monitor.

C1-11.3 RELEASE OF THE MASTER TEST FRAME CONNECTOR

When the marker has reached the point of operating the channel hold magnets, it grounds the HMS1 lead to operate the RTC1, release master test frame connector relay. The RTC1 operates the RTC2 and releases the MON and MON1 relays.

When the monitor preference relay in the MTFC releases, the CI releases to remove ground from the ON lead to the MTFC so that the MTFC can completely release. The release of the CI releases the MTFC cut-in relays, the C11 relay, the MCA and MCB relays at the monitor, and the MTR1 relay. The release of the MTR1 relay closes the TRB lead. This control of the TRB lead prevents operation of the TRB during release of the MTFC.

The operation of the RTC2 relay prevents the monitor from interpreting normal release of the register as an abandoned call. The RTC2 relay operates the MPC2, monitor plant register call counting relay, which in turn operates the MPC1 relay. This releases the MPC2 to cause operation of the CKS, number check start, relay. The operation of the MPC2 also causes the peg count register to operate. The RTC2 relay causes the MB relay to operate. The MB relay is operated so that the register can be held busy at the end of the call until the monitor has checked the number and made a trouble record, if necessary.

C1-11.4 NUMBER CHECKING

The CKS relay locks operated and connects resistance battery to the check path. Each relay used in registering the pulsed number as received by the monitor is paired with a corresponding relay which records the number passed from the register to the marker. This check path is wired in such a way that the two numbers must be exactly the same. If the numbers recorded are the same the CKN, number check, relay operates. The CKS also operates the CKE, number check ended. The CKE relay is a slow operate to permit the CKN to operate if the check path is complete. When the CKE operates ground is extended through break contacts to operate the TRR1, trouble recorder release, relay or through a make contact of the CKN to release the monitor and register.

C1-11.5 FAILURE OF NUMBERS TO MATCH AND TROUBLE RECORD

If the TRR1 relay operates, it locks and operates TRR2. The TRR1 relay grounds the MN lead to the MTF jack, lamp and key circuit to indicate with an audible alarm that a trouble record is being made. The TRR2

relay opens the OK lead to prevent a late number check from releasing the monitor. The TRR2 also closes a ground through the ORN, originating register off-normal, relay to operate a plant register which indicates the number of originating register troubles encountered. The MKB lead is opened by the TRR1 relay to prevent operating marker cut-in relays.

The TRR1 relay also closes battery to the TRST lead to operate the monitor preference relay in the MTFC. If the MTFC is idle the monitor gains access and operates the CI and CII relays. The CII relay grounds the STR lead. This ground prepares the trouble recorder and MTFC to receive a trouble record. The CII also operates the multicontact relays MCA, MCB and MCE relays.

The relays previously operated to record the calling line location, marker number and the called number passed from register to marker extend their locking grounds into the MTFC through the MCA and MCB relays. The called number registered directly by the monitor is extended through the MCE relay to the MTFC. The MOR lead to the MTFC is grounded through the ORN and MCA relays to indicate that the trouble record is being made on a monitored originating register call.

The register may release but the M, monitor, relay and the MB, make busy, relays in the register will be held operated from the monitor. The M relay is held operated to allow identification of the register by extending the RG, register group, FR, frame; and CN, connector, leads through the M and MCA relays.

After a trouble record has been perforated the TRC, trouble record complete, relay operates. The TRC relay operates the RN, return monitor to normal, relay. The RN relay operates and opens the register holding path and both register and monitor release.

C1-11.6 MONITOR RELEASE

In restoring the monitor to normal, the RN relay is operated from the TRC relay if a trouble record has been made or an OK relay if the number check was satisfactory. An OK release signal is also received if a call is abandoned or if a trouble release is received from the marker. The RN relay initiates a series of events that allows the marker, register and monitor to completely release as shown on SFD-C144.

SECTION C, PART 2
SENDER SELECTION AND CONTROL

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C2 SENDER SELECTION AND CONTROL

A No. 5 crossbar office is required to supply information to a connecting office when a call is routed through or completed in the connecting office. Senders are used to store the call information received from the markers. The senders may be required to convert information to multifrequency signals or pulse trains (a string of pulses) that can be used by the connecting offices. The connecting offices may be of various types and each office type may require a different sender type to work with that office. Senders are arranged into sender groups, with a maximum of ten senders in a group. The senders in a sender group have the same type of pulsing. There can be a maximum of twelve sender groups in an office (marker group). Each sender group is subdivided into sender subgroup A and sender subgroup B, with a maximum of five senders in a subgroup.

C2-1 IDLE SENDER TEST (SFD-C204)

If the route selected requires a sender, the marker grounds its OS-punching through the operated route relay. The OS-punching is cross-connected to an OSG-punching to select an outsender group. Operation of the OSGO-11, outsender group, relay operates marker off-normal relays, OGC, OSC, and SON. These relays prime the marker to work with the sender. The operation of the OSG-relay extends test leads from the marker to the selected group of senders to determine which subgroup within the selected group has idle senders. Ground on the SIE, sender idle even, (for even numbered markers) or ground on SIO, sender idle odd (for odd numbered markers) from subgroup A or B will operate SIA and/or SIB relays depending on whether one or both sender subgroups have idle senders.

C2-2 SENDER SUBGROUP SELECTION (SFD-C205)

It is necessary to determine if the outsender connector associated with subgroup A or B is busy. The OSG-relay extends the GBE, group busy even (for even numbered markers) and GBO, group busy odd (for odd numbered markers) leads from the outsender connector to the marker. The presence of ground on either lead indicates the connector is busy. This ground also operates GBA or GBB relays. The operation of the SIA or SIB relay or the GBA or GBB directs the marker to seize one of two connectors. The OSC, outsender connector, is seized when the marker extends battery over the start lead to operate the MP-, marker preference, relay in the OSC preference control circuit. To check that the MP-relay operates, ground is extended through the MP-relay to the completing marker to operate the SKA or SKB, sender connector check subgroup A/B.

C2-3 SENDER SELECTION (SFD-C206)

The operation of the SKA or SKB operates the OSGA or OSGB relay in the OSC associated with the selected subgroup. The operation of the OSGA or OSGB relay extends the OSO-4 leads from the marker to the selected sender. Ground on any of the OSO-4 leads indicate an idle sender and operates the associated OS- relay(s). If more than one OS- relay operates, the setting of the marker junctor sequence circuit will determine which sender is preferred. The operation of one or more OS- relays operates the OSE and OSE1, outsender end, relays. The operation of the OSE relay indicates that the sender has been seized. After the sender is selected, the OSE1 relay tests the OS- lead to check that the OS- relay was not operated falsely. When the SB (sender busy) relay operates, ground from the sender is removed and the OSE1 should release. If more than one OS- relay is operated (indicating more than one sender is available) the preferred OS- is lock operated and all others released.

C2-4 CONNECTION OF SENDER TO A TRUNK

The marker connects the sender to the outgoing trunk through the crossbar switches in the OSL, outgoing sender link, frame. The outgoing senders are connected to the horizontals of the crossbar switch and the outgoing trunks connected to the verticals. The OSL select magnet is operated when the sender is selected and the trunk link is seized. The operation of the hold magnet must wait until the outgoing trunk connection is complete. The completing marker is performing many functions as it connects to the sender. The selection of the trunk link and trunk coincide with the sender functions, even though these functions are described later in the SCD.

C2-4.1 OPERATION OF THE OSL SELECT MAGNET (SFD-C206)

The operation of the SKA or SKB relay operates the SSA or SSB relay. Contacts of these relays close the ten select magnet leads either to the XSS relay or to the OSO-4 relays. With the nonpreferred OS- relays released and the SSA or SSB relay operated, the OSL select magnet SS- associated with the selected sender operates.

C2-4.2 OPERATION OF THE OSL HOLD MAGNET (SFD-C206)

After the SS- select magnet operates, battery is extended from the winding of the hold magnet, through the make-contact of the trunk F relay, through the off-normal contact of the OSL select magnet to the winding of the high resistance polar relay SHK, sender link hold check. The high resistance winding of the SHK relay prevents the SH hold magnet from operating, but tests the lead by operating the SHK. The operation of the SHK operates the SHKA (sender link hold check auxiliary), relay.

If the dual voltage method of operating the OSL hold magnet is used, the operation is as follows. When the SON relay operates prior to the operation of the SHKA relay, the SH1-2 capacitors are charged to +130 volts with respect to ground. The operation of the SHKA relay isolates the +130 volt charging source and completes the circuit through the SH1-2 capacitors, the SLK (sender link check) relays, and the SH- hold magnet. The SH1-2 capacitors discharge through the primary winding of the SLK relay to ground, through the -48 Volt battery source, through the SH- hold magnet, to the side of the SH1-2 capacitors. This applies 178 volts to the circuit, the +130 charge in series with the -48 volts on the hold magnet, to cause fast operation of the SH-hold magnet. The current flowing through the SLK relay primary winding overcomes the bias and operates the SLK relay. When the charge in the SH1-2 capacitors discharges to the level that -1/2 volt is standing on the SH diode with respect to ground, the SH diode is forward biased to allow steady current to hold the SH- hold magnet and the SLK relay operated. The operation of the SLK relay operates the SLK1 (sender link check auxiliary) relay to indicate that OSL crosspoints should be closed. The ground holding the OSL hold magnet operated extends through the OSL crosspoints to operate the sender ON (off-normal) relay. The ON relay operates the sender CT (cut-through) relay and cuts through the tip and ring leads to the trunk. The ON relay also operates the trunk D (disconnect) relay which removes the tip and ring leads of the outgoing trunk from the trunk pair. This allows the sender to signal the distant office to set up the connection in that office. The LR (line release) relay in the sender operates to provide a holding ground for the OSL hold magnets. The operation of the D relay operates the trunk S1 (supervisory) relay which provides holding ground for the LL and TL hold magnets. The operation of the S1 is checked at this time by the operation of the LR. When the LR relay operates, ground is extended to the ON relay to lock it operated, back through the OSL crosspoints to control the OSL hold magnets, back to the marker SLK relay to shunt the primary winding of the SLK. The release of the SLK operates the marker SLK2 relay which indicates control of the OSL has been turned over to the sender, and the OSL crosspoints are closed.

C2-5 OPERATION OF THE INDIVIDUAL AND COMMON CHANNELS

The operation of the OSKA (outsender check auxiliary) relay and the preferred OS- relay in the marker operates the S- relay in the OSC to establish an individual channel between a particular marker and a particular sender. This individual channel relay is used to operate the sender part of the common channel, to pass AMA recorder number class, advance and reorder information between the marker and the sender. It is necessary to pass this information through the S- relay because the common channel releases early to free the OSC for use on other calls.

The common channel consists of two parts, the marker part and the sender part. The relays are multicontact relays designated MA1-2, MB1-2, and MC1-2 for the marker part, and SA1-2, SB1-2, and SC1-2 for the sender part. The physical location of the MA-, MB-, MC- relays is on the OSC frame. The physical location of the SA-, SB-, SC- relays is on the sender frame.

C2-6 CALLED NUMBER TRANSFER TO THE SENDER AND DIGIT CHECK
(SFD-C208, C209)

When operating with trunk circuits, the OGC relay operates the KG (called number digit cut-in ground) relay. This relay operates the KA, KBC, KDE, KFG, KHJ, and KKL, cut-in for the A digit for the B and C digits, etc. These relays are used to cut through the A2/5-L2/5 leads from the register, through the marker to the sender. The A2/5-L2/5 relays operate in the marker and in the sender. The operation of the ORK1 and ORK2 (outgoing registration check) relays indicates that the proper number of A2/5-L2/5 relays operated. If the ORK1, ORK2 relays remain operated after the digit cut-in relays have released, they indicate that the registration relays in the sender locked operated. On some calls, the sender is not required to transmit the A, AB or ABC digits and is not required to receive them even though they are registered in the marker. Since the ORK1,2 must remain operated to indicate a successful transfer of all digits, the ORK1,2 operating path is arranged to bypass the digit check relay contacts of the deleted A, AB, or ABC digits. When the sender relays with the deleted digits fail to return a locking ground to the associated marker digit check relays, the release of these relays does not open the operate path of the ORK1,2.

C2-7 MARKER INPUTS TO THE SENDER (SFD-C210-212)

The ground to operate the CL-, DL-, CR-, CP- etc., relays in the sender and related check relays in the marker originates in the marker through the operated TGS1 and TGS2, transmitting ground supply, relays. The TGS2 relay operates only on AMA calls. The circuits function the same to check information stored in the sender but only one typical circuit will be discussed. On SFD-C211, the operation of the TGS1 relay operates the DLK1 relay and extends ground through the DL- relay through the OSC frame to operate a DL- relay in the sender. The operation of the ON1 relay in the sender locks the DL- relay operated through its own make-contacts. When the OST2 relay operates at a later time, the TGS1 relay releases. The ON1 ground in the sender should extend back to the marker to keep the DLK1 relay operated as a check that the DL- relay in the sender is locked operated. If the DLK1, CLK1,2 etc. fail to remain operated when the TGS1 releases, the completing marker will stop its progress at the RSC relay, time out, and deliver a trouble record.

C2-8 OST, OST1 AND OST2, OUTGOING SENDER REGISTRATION TIMING
(SFD-C203, 214)

The purpose of the OST, OST1 and OST2 relays is to allow sufficient time for the sender registration relays to operate. The outgoing sender registration timing is started when the cut-through relays operate and ground is extended over the TSR lead. On non-AMA calls, ground is extended through the OSC multicontact relays, through the KK, TGS1, ORK1/2, the OST released, and the OST2 released to operate the OST1 relay. The OST1 locks operated under control of the KK and TGS1 relays. Also, the OST1 removes the shunt from the OST relay allowing the capacitor OST to charge. When the OST capacitor is fully charged, the bias on the secondary winding is removed allowing the OST relay to operate. The operation of the OST relay transfers the TSR ground through its make-contacts through the OST1 make-contacts to operate the OST2 relay. The operation of the OST2 relay releases the cut-through, TGS1 and other relays. The release of the KK and TGS1 relays release the OST1 relay. Ground on the OST2 make-contact (SFD-C214/F3) extends through the OSE1 released, the OST1 released the RK3 operated, the OST released, the OST2 operated, through sender information check relays operated to operate the RSC (release sender connector) relay.

C2-9 SENDER ADVANCE (SFD-C206, 207)

After the marker has checked that the connection has been established, as indicated by the operation of the DCT (SFD-C533, C534) and the GT1 (SFD-C531) relays, and that the information has been transferred satisfactorily (as indicated by the operation of the RSC relay SFD-C214) an advance signal is given to the sender. The marker operates the advance relay in the sender. If the call is AMA, it is necessary to also check that the recorder number information has been checked by the RNK1,2 relays (SFD-C214).

The sender AV relay operates in series with the primary winding of the AVK relay and the AVK1 resistor. The operate current for the AV relay flows in the direction to hold the AVK relay nonoperated. The AV relay is operated just before the marker disconnects from the connection, after determining that all checks are satisfactory.

After the AV relay has operated, it locks to ground in the sender. This locking ground is extended to the marker over the AV lead from the OSC. The AV lead is through the individual channel (S relay part of the OSC) as the common channel has been released. This locking ground is extended to the primary winding of the AVK relay and causes current to flow in a direction to operate the relay. The operation of the AVK relay indicates that the sender AV relay is locked operated.

After operating, the AVK relay operates the advance check auxiliary relay. The operation of the AVK1 relay causes the marker to perform linkage checks and then to disconnect (SFD-C5 and C6 sections).

C2-10 TRUNK GUARD TEST (SFD-C215)

Markers are arranged on light traffic to delay disconnect from the sender until the sender makes a TGR (trunk guard) test. A trunk test is made by the sender to test for battery and ground on the tip and ring conductors. The marker retains control of the sender by holding the individual channel. If the sender finds an open trunk toward the distant office, the marker will time out, take a trouble record and set the sender to return a reorder signal to the trunk. The marker TG relay is operated when the sender ON relay operates. The sender grounds the TG lead until it detects battery and ground on the tip and ring conductors with the operation of the OF1 relay. If the sender trunk guard test is satisfactory, the marker LK1 linkage check relay operates the marker D1S1,2 (disconnect) relays. If the sender trunk guard test is not satisfactory, the marker LK1 relay operates the marker TGT relay. The TGT relay holds the OSC S- relay operated, operates the D1S1,2 relays to allow the rest of the marker to release, starts the SFT (seize frame timer) holds the MCBO, 1 relays operated so that the marker cannot be seized, holds the TS-, FS- and TB relays operated to identify the trunk and holds the OSG- and OS- relays operated to identify the sender involved.

C2-10.1 TRUNK GUARD TEST SATISFACTORY

The sender starts the TG test when the marker operates the sender AV relay. If the sender TG relay operates before the marker SDT timer functions, the marker TG and TGT relays release and the marker disconnects.

C2-10.2 TRUNK GUARD TEST FAILURE

If the trunk is open, the sender TG relay does not operate and the marker SDT timer functions and causes a trouble record to be taken. When the trouble record is taken, the TRB1 (trouble recorder busy) relay operates. Operation of the TRB1 grounds the R0 lead to the sender which sets the trunk to reorder. The TRB1 relay in operating also releases the TG and TGT relays which release the marker.

C2-11 SUBSCRIBER OUTGOING FUNCTIONS WITH AMA

C2-11.1 ROUTE SERIES

The message billing information is required only on AMA calls for charging purposes. One MBS0-9, message billing series, relay is operated in series with the route relay when the code point is grounded.

C2-11.2 MARKER CONTROL FUNCTIONS WITH AMA

The operation of the route relay for an outgoing call that requires a sender operates an OSG- relay. The OSG- relay operates the OGC relay. On AMA calls, the OGC relay operates the TGS2 (transmitting ground supply), RN (recorder number), and SCC (service call), or TVA (transverter test call) relays. Since the TGS2 relay operates only on AMA calls, it extends ground to circuits that are concerned only with AMA functions.

The code pattern information is used on AMA calls to indicate the structure of the called number. The marker determines the code pattern and number structure information by operating one of the CP0-9 (code pattern) and CPP (code pattern primary), or CPS (code pattern secondary) relays. The operation of these relays determine the code pattern and number structure information transferred to the sender over the CP2/5; 4DG (4-digit number structure), 5DG (5-digit number structure), L5D (lettered 5-digit number structure), LST (lettered station number structure) leads.

C2-11.3 INDIVIDUAL AND COMMON CHANNEL IN THE OSC

The operation of the S- relay in the OSC establishes an individual channel between a particular marker and a particular sender. The operation of the MA-, MB-, MC- (on AMA calls), SA-, SB- and SC- (on AMA calls) multicontact relays establish a common channel between the markers and senders.

C2-11.4 MARKER INPUTS TO THE SENDER ON AMA CALLS

When the channels are established between the marker and the sender, ground is extended from the marker to the sender to record information in the sender to be passed on to the AMA transverter at a later time. The operated TGS2 relay operates check relays in the marker and extends grounds through information relays to the sender. The TGS2 operates the MBK 1-4, NSK1, and CPK1-2 relays in the marker and grounds leads to the sender to operate the MB2/5, AMA, SC/TVT, CP2/5, TP/RP and 4DG/5DG/L5D/LST relays.

The GTL2 relay, which operated earlier in the call, extends ground through the calling line location information relays to the sender. These information relays are FT2/4 (frame tens), FU2/5 (frame units), HG2/5 (horizontal group), VG2/6 (vertical group), and VF1/5 (vertical file).

C2-11.5 TRANSMITTING AND CHECK OF RN-RECORDER NUMBER (SFD-C214)

The RNT (recorder number timer) circuit is used to determine if RN-, OBS/NOB, and CL- information has been sent to the sender and locked to ground in the sender.

The RNT relay operates when the AMA5 relay operates. Ground on the TSR lead provides a path to operate the RNT1 relay if the RN- and MBK5 relays are operated. The operation of the RNT1 indicates that ground is being transmitted to the sender over the RN-, OBS/NOB, and CL- leads. Operation of the RNT1 also causes the RNT to start operating as determined by the charge time of the RNT capacitor. When the RNT relay operates, it operates the RNT2, which causes the RN relay to release and open the ground path to the RN-, OBS/NOB, and CL- relays. These relays release if corresponding relays in the sender have not operated and locked to ground. The release of the RN also releases the RNT1, which causes the RNT to release as timed by the discharge of the RNT capacitor. This time is provided to permit the RN- relay to release if the sender relays did not lock to ground. When RNT releases, the RNK1-2 relays operate through the RN- and MBK5 as an indication that the information has been transmitted and locked in the sender.

C2-11.6 RSC, RELEASE SENDER CONNECTOR RELAY OPERATION ON AMA CALLS (SFD-C214)

The RSC relay checks that the correct information was sent to the sender, and this information is locked to ground. On AMA calls, the operation of the RSC is different. When the OST2 relay operates, the GTL and GTL2 relays release. Ground through all the check relays re-operates the GTL and GTL2 relays. The reoperation of the GTL, with the OST2 operated, operates the RSC.

SECTION C, PART 3

CONNECTION TO A TRUNK LINK FRAME AND TRUNK

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C3 CONNECTION TO A TRUNK LINK FRAME AND TRUNK

When a completing marker has been seized and has received input information through the ORMC, it proceeds to select a TL having an idle trunk of the correct type. It then proceeds to select and connect to a trunk.

C3-1 TRUNK LINK FRAME SELECTION

C3-1.1 TEST FOR IDLE TRUNKS ON TRUNK LINK FRAMES

The completing marker determines which trunk link frames have at least one usable trunk when it operates a route relay. All trunks of the same route on a trunk link frame have the FT leads multiplied together and cross connected to the FTC (frame test common) terminal for that particular route. At the trunk link end, the FTC lead corresponds to the route relay number. At the marker end, the FTC lead corresponds to the trunk link frame number. The operated route relay closes through individual FTC leads to each trunk link. If at least one trunk is idle, ground from the trunk will ground the associated FTC lead and operate an associated FTC relay in the marker. The FTC leads are used in common by the markers, and one or all markers can connect to the same FTC lead at the same time.

C3-1.2 TRUNK LINK FRAME BUSY TEST

To prevent marker delays, it is necessary to determine which TLs are being used by other markers. The operation of the BCO (busy cut-in), BC10, and BC20, (busy cut-in auxiliary) relays extends the windings of the FB029 (frame busy) relays to the associated TL to check if the frame is busy. If the TL is busy, the associated FB- relay operates. To select a TL, the associated FTC relay must be operated while the FB- relay is non-operated.

C3-1.3 TL PREFERENCE ORDER OF SELECTION CONTROLLED BY MEMORY OF PREVIOUSLY SELECTED TL

Frame memory relays have been provided to equalize traffic to the trunk link frames. The FMG (frame memory group) relay and the FM- (frame memory) relay will be held operated from the previous call to record the identification of the TL used in that connection. This information is locked in the marker and on the next call will be used to make the succeeding TL first choice for the marker. However, if the first choice TL is not available for service, the next preferred TL is selected.

As described in paragraph C3-1.6, after the TL has been selected, the frame memory relays which have been locked operated to identify the last TL used are released. The frame memory relays identifying the TL used in this connection are then operated.

C3-1.4 FRAME SELECTION, OPERATION OF THE FS0-29 RELAYS

The operation of a FS0-29 (frame select), relay indicates the TL to be selected to complete this connection. The operation of the FS- relay depends on:

- (a) The operation of the FTC- relay with the associated FB- relay nonoperated, indicating an idle TL with an idle trunk of the desired type.
- (b) The setting of the FMG- and FM- relays.
- (c) The operation of the FMG relay indicating that the frame memory relays have been held operated from the previous call.

The FS- relay which operates will generally be associated with the second higher numbered frame than the frame recorded on the frame memory relays. The reason for advancing the frame selection in steps of two is in the event of paired trunk links where all channels are busy and the marker is recycled, it will always be advanced to a different TL. This prevents the marker from staying in the same TL and allows another set of junctors to be tested.

C3-1.5 TRUNK LINK FRAME SEIZURE

Operation of an FS- relay closes start battery to the preference control circuit associated with the trunk link frame having the same number as the operated FS- relay.

C3-1.5.1 Preference Control Circuit

The preference control circuit associated with trunk link connectors provides two preference relays MP (marker preference) and E (emergency marker preference) per marker for each trunk link connector. There is means for detecting trouble associated with both the MP- and E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by three chain circuits which enable connection of one marker at a time to a trunk link frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to the E- relays.

C3-1.5.1.1 MP - Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a TL), MP- relay operation is straightforward. A start signal battery from a marker is applied to

the associated MP- relay winding which is connected through the MP- operate chain to ground at the winding of the first relay in the operate chain. In periods of heavy traffic, two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first and last markers in the preference chain initiate simultaneous request for connection to the same TL. Both MP- relays will operate and lock. If, however, the last marker has initiated a request slightly before the first marker, the MP- relay for the first marker could not have operated because ground for its winding would have been opened by the operate chain at the MP- relay for the last marker. On the other hand, if the first marker initiated a bid first, any other marker ahead of it in the operate chain could subsequently operate its MP- relay.

C3-1.5.1.2 MP - Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, two work chains determine which MP- relay does the work. The work chains progress through contacts of the MP- relays in the opposite direction to the operate chain, starting with ground at contacts of the MP- relay for the first marker. If the MP- relay for the first marker is operated, one work chain ground will operate the M trunk link connector relay whether or not other MP- relays are operated. The M relay operates other connector relays by closing through battery supplied by the marker.

The second work chain grounds the CK lead to the marker which has gained access to the trunk link frame to operate the TFK1-2 (trunk frame check) relays in the marker. The TFK1 relay provides a locking ground for the FS relay which had closed through the start battery to the preference control circuit. The TFK1 relay also opens the ground from which the FS relay had operated. When the marker which has seized the TL has finished its job and opened the start lead to the preference control, its MP relay is released. If there are any other operated MP relays, the next MP relay in the work chain which is operated will function as just described. This procedure continues until all operated MP relays have been served.

C3-1.5.1.3 Emergency Transfer (SFD-C306)

Two sets of preference relays MP and E are provided in the preference control, either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR- relay are normal so that MP relays are active. When all MP relays are normal, ground through all the break contacts of the operate chain is connected to one side of

the CH relay winding, and ground through all the break contacts of the work chain which operated connector relays is connected to the other side. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again, the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP relays are all normal, one side of the CH relay winding will have ground and the other resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open or if there is a false ground on either chain when one or more MP relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other and will operate.

If the CH relay operates, even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the SF, CK, and MC leads from MP relays to E relays. The TR relay also brings in a minor alarm and lights a CH lamp.*

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP chain if the TR key is normal or to the E chain if the TR key is operated.

C3-1.5.1.4 Manual Transfer

By operating the TR key, located at the TLCC (trunk link connector control frame), preference control can be manually transferred from the MP to the E relays. The TR key operates the TR relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E relays. If the CH relay operates, it operates the TR relay which locks and releases the TR-relays to transfer preference back to the MP relays.

C3-1.5.1.5 Frame Busy Signal (SFD-C304, 305)

When the trunk link connector relays operate, they ground FB leads to all markers as an indication that the trunk link frame is now busy. In all markers except the one that seized the TL, operated FB relays cause the release of associated FS relays (if operated) and operation of another FS relay (assuming another FTC relay is operated with a normal FB relay). In the marker which had seized the TL, the locking ground from the operated TFK1 prevents release of the FS relay. The operated TFK1 also prevents operation of any other FS relay by its removal of the

* Although the CH lamp is shown as part of the trunk link connector circuit, it and the alarm release key are located on a frame designated as "trunk link connector control".

operate ground for FS relays. Thus, any other markers establishing outgoing connections will remove their bid for the particular TL and possibly bid for another which had idle trunks. As will be seen later, completing markers handling incoming trunk calls can only go to one TL and will continue their bid for the same TL.

C3-1.6 RECYCLE OF FRAME MEMORY PREFERENCE (SFD-C307)

After the trunk link frame has been seized, the marker resets the frame memory relays. The operation of relay TFK1 removes the locking ground from relays FM- and FMG- held from the previous usage, thereby allowing them to release. The release of relays FM- and FMG- releases relay FMK, frame memory check, which releases relay FMG. The release of relay FMG, together with the operated relays FS, TFK1 and TFK2 on this usage, operates the FM- and FMG- relays that correspond to the trunk link frame being used. Relay FMK reoperates. Because relay TFK1 is operated, relay FML (frame memory lock) operates and relay FMG remains nonoperated and provides a locking ground for the FM- and FMG- relays. The operation of relay FML releases relay BCO, 10, and 20, opening the trunk link frame test leads and releasing the operated FB relays. The FML relay operated opens a break contact in the FMK (frame memory check) relay circuit. This now ensures that the FMK relay will remain operated only when both FM- and FMG- relays are operated. The FMK and FML relay operation is represented on the trouble record card by progress punch FML. Failure to lock the new frame memory relays will be detected at the time the marker prepares to operate the disconnect relays DIS1 and 2, disconnect, relays through make-contacts of the FML and FMK relays (SFD-C605). A trouble record will be produced showing no FML punch.

C3-2 TEST AND SELECTION OF AN IDLE TRUNK (SFD-C308, C309)

As soon as the trunk link frame is seized, the marker proceeds to test and select an idle trunk. The various steps are as follows.

C3-2.1 TRUNK BLOCK AND TRUNK GROUP CONTROL

Most trunk link frames (SD-26032-01) have ten level crossbar switches which provide a total of 160 trunk terminations of which no more than 120 can be seized by the completing or dial tone markers. Each group of trunks or originating registers is assigned one of six TB- (trunk block) numbers and are of 20 TG (trunk group) numbers for a maximum total of 120 routes.

The marker indicates which TB- and TG- relays will be used by operating its route relay. The marker identifies a particular route by placing a battery on the TB- lead and ground on the TG- lead. The battery on the TB- lead operates a TB- relay in the trunk link frame. The operation of the TB- relay in the TL cuts through 20 BT leads, BT00-19 to the completing marker to battery.

C3-2.2 CROSS CONNECT OF THE TG- TO F- PUNCHINGS

Each trunk has an F lead. This lead is connected to an F punching. All these F punchings, for trunks which have the same TG- number, are connected to the corresponding TG- punching.

C3-2.3 BT00-19, BUSY TEST, LEADS

In the trunk, each F lead is connected through an F relay winding (through contacts which are open while the circuit is busy) and then to a BT punching. In testing for an idle trunk, the marker grounds one TG lead. This results in the grounding of the F leads of all trunks of the desired route as well as those of other routes of the same TG-number. The marker also operates the TB- relay corresponding to the TB- number of that route. Only BT- leads corresponding to trunks of the desired route will have resistance ground on them because the TB- relay selected only those with the proper TB- number and the TG- lead provided ground to only those of the proper TG- number.

The TB- relay connects 20 BT leads into the marker. Any number of the BT00-19 leads may be assigned to one route. However, it should be noted that some of the routes may be unavailable because all of the BT- leads may be in use for other routes. For example, suppose that a route in TB3 has 18 trunks associated with it on one trunk link frame, then there will be only 2 BT- leads left for the other routes in TB3. Consequently, only a maximum of three routes out of twenty can be used on TB3, on that frame.

C3-2.4 OPERATION OF THE TB- RELAY IN THE TRUNK LINK; THE TBK, TRUNK BLOCK CHECK, AND THE TSE 1,2, TRUNK SELECT END, RELAYS IN THE MARKER

To check that the TB- relay operates in the TL, ground is extended back to the marker on the TBK lead to operate the TBK (trunk block check) relay. When the TLC1,2 (trunk link control) relays operate they permit the marker to determine that none of the TS- (trunk select) relays are operated by the operation of the TSE1,2 relays. The operated TSE2 relay provides the battery for operating the TT0-9 (test trunk) relays.

C3-2.5 OPERATION OF THE TT0-9 RELAYS

The TT0-9 relays are double wound with each winding being connected to one of the BT00-19 leads. An idle trunk is indicated by the operation of a TT- relay. The operation of any TT- relay does not alone indicate the particular trunk that is idle. The marker must determine which one of the two is grounded with an odd and even preference lockout circuit.

C3-2.6 OPERATION OF THE TS0-9 RELAYS AND RELEASE OF THE TSE1,2 AND TT0-9 RELAYS

After the TLC1, TSE1, TBK and MAK1 relays operate, ground is extended through the marker junctor sequence circuit to operate the TS0-9 (trunk select) relays. The operated TS- relay locks under control of the TLC1 relay and releases the TSE1,2 relays. The TSE2, in turn, releases the TT0-9 relays. With the operation of the TS- relay, marker selection of a trunk is directed to one of the two trunks which appear on a particular TS- relay. These leads, which indicate idle trunks when grounded, are extended to an OTS (odd trunk selection) or ETS (even trunk selection) relay to permit selection of one of the two trunks.

C3-2.7 OPERATION OF THE OTS AND OT OR THE ETS RELAY

The ETS and OTS relays are double wound polar relays. The current through the primary winding is in a direction to operate the relays, and the current through the secondary windings is in a direction to hold the relay non-operated. When both windings are energized, the current through the bias, secondary, winding is sufficient to hold the relay non-operated.

The TZ-, trunk preference (Z), relay is used to change preference on each marker usage.

If the TZ relay is non-operated, the bias winding of the ETS is opened. Therefore, with ground on both the odd and even BT- leads the ETS relay operates and the OTS relay is biased non-operated. However, if the TZ relay is operated, the OTS bias winding is open and the OTS and OT relays operate.

C3-2.8 SEIZURE OF THE TRUNK AND OPERATION OF THE F RELAY IN THE TRUNK

The busy test (test for idle trunks) is made with high resistance TT-relays. The F relay of the trunk does not operate in series with the TT- relay. The operation of the OTS or ETS relay changes the high resistance to a low resistance, which locks the OTS or ETS operated and operates the F relay in the trunk.

C3-3 SENDER NO DIGIT AND TRUNK TT- RELAY CONTROL (SFD-C310)

The sender may be used on calls which require no dialing. Trunk test calls are of this type. Also, in some cases, the sender is used to obtain a path for operating the tandem relay of the trunk. Another type of no dialing call is the intra-office AMA, when the sender is used in connection with the initial entry record.

For these types of calls, the marker primes the sender with the usual digits and AMA information, and in addition operates the STS (start digit steering) relay over the ND (no digit) lead. The STS relay operates the EP (end of pulsing) relay. The STS, rather than the EP, is connected to the ND lead because the marker requires a fast operating relay on this lead. The EP is slow operating so it will not operate falsely on a regular dialing call from a pulse which may occur if the RR- relays are normal during a changeover from one digit to another.

The MT12 (marker test) relay operates only on marker test calls and certain trunk tests when the marker is required to operate the TT relay in the trunk.

The OTT (operate trunk test) relay operates under the following conditions:

- (a) OGT - Outgoing trunk type of test from the master test control frame.
- (b) SDR - Sender test using the AMRST (automatic monitor, register, and sender test circuit).
- (c) LV3 - Line verification test circuit in the master test control frame.
- (d) ITDO - Incoming trunk in the distant office test from the master test control frame.

To operate the OTT under the above conditions, the MT12 and OGC relays are operated and the NSI (no sender intra-office) relay is released.

The operation of the OTT relay extends ground through the TT- cross connects, through level relays in the TL to operate the TT relays in the trunk. This same ground operates the TTK, OTT relay check in the marker, and if the TT relay in the trunk is locked operated, keeps the TTK from releasing when the SK, S1 relay (trunk) check, relay operates.

C3-4 OPERATION OF CONTROL RELAYS IN THE TL FRAME (SFD-C311)

When the F relay in the trunk is operated, it operates an FA- or FB- relay. The FA- or FB- then operates a LVO-9 (level connector) relay. There is one of these relays associated with each of the levels (horizontal) of the trunk switches.

Assume that an A appearance is involved and the FA- relay operates. When one FA- and one LV- relay operates, several leads are connected to the marker through the TLC. These are the following:

- (a) The FAK informs the marker that the trunk is on the A appearance and checks the operation of the FA relay.
- (b) The AST connects the crosspoint sleeve into the marker for test purposes when cross points are being set up.
- (c) The ASM connects the associated directing and trunk select magnets into the marker.
- (d) The ALC connects an operating circuit, for the link connector relay associated with the trunk switch in which the trunk appears, into the marker.

The marker uses the LVK lead to check that only one LV- relay operates. If the trunk is connected to a B appearance, the FB- (B appearance trunk connector) relay operates, operating the LV- relay. A similar set of leads is closed through to the marker except the designations have a B instead of A, ie., FBK, BST, BSM and BLC.

As soon as the FA- or FB- relay operates, it operates an LCO-9 (link connector) relay. One of these relays is associated with each trunk switch and it grounds the LCK lead to enable the marker to check its operation and, in conjunction with R (right side of frame), and L (left side of frame), relays connect ten links of the associated switch into the marker for channel test purposes (SFD-C502).

C3-5 TRUNK CLASS CONTROL AND TRUNK CHARGING (SFD-C312, 313)

As previously shown, a route relay may be associated with various route series relays to control the transmission of trunk class information to the trunks. The various types of trunk class information are as follows:

- (a) Charge or noncharge - the presence or absence of a signal on the TC lead indicates a charge or noncharge condition respectively.
- (b) Tip and ring party - the presence or absence of a signal on the TP lead indicates a tip or ring calling party respectively, and is used with a charge call when a distinction must be made to charge the right party. The TP signal may be used on terminating calls to operate a ringing selection switch hold magnet.
- (c) Coin or noncoin - the presence or absence of a signal on the CN lead indicates a coin or noncoin calling customer respectively. This signal is used by the trunk to control the selection of control equipment when required.

Where the aforementioned signals are not required for the conditions stated for a particular trunk, the same signal may be used for other purposes.

For example, a signal on the TC lead may be used to identify calls to an operator that would normally be charged for, and notify the operator by a tone that a ticket should be made on the call.

The marker insures that the trunk class signals are locked in the trunk when making the linkage check by checking the operation of either the NOC (no class transmitted) or the CLK (class check) relays.

C3-6 TRUNK BUSY TIMING

The trunk busy test timer starts where the marker begins testing the trunk group for an idle trunk. If the marker does not detect a TL with an idle trunk within 27.5 to 30.5 milliseconds on service calls or 79.5 to 95.5 milliseconds on test calls, the TBT (trunk busy timing) relay operates to indicate an all trunks busy condition.

The trunk busy test timer is started by seizure of the trunk link frame and operation of the TBK (trunk block check) relay. If a trunk is not selected, the TBT relay operates to indicate all trunks busy when the TA (trunk available) relay is released or an open BT or TG lead if the TA relay is operated. If the TA relay is operated a trouble record is requested on first trials and a route advance on second trials.

SECTION C, PART 4

CONNECTION TO LINE LINK FRAME

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C4 CONNECTION TO LINE LINK FRAME

Following seizure of the trunk link the line link on which the calling line is located is seized. This gives the CM (completing marker) access to and control of the calling line select and hold magnets.

C4-1 LINE LOCATION CONTROL (SFD-C402, C403, C412)

On an outgoing call the CM does not use the FLG (forward linkage), but does use the SCB (call back linkage). The call back linkage connects a trunk on a TL to the calling line. On an OGT call the CM starts the call back linkage as soon as the call is indicated as a SOG (subscriber outgoing call). From the selected route the CM obtains a SON (sender off normal) or a NSO (no sender outgoing) indication which operates the SOG1 and SOG2 relays, in turn, operating CB, CB1, CB2, CB3, CB4, and CB5 (call back) relays. The CM receives calling line identification from the OR which is registered on the FT-, FU-, VG-, HG- and VF- relays and produces the FT'-, FU'-, VG'-, HG'-, and VF'- prime punches. This information along with the LL- (indicating which line linkage was used on the dial tone call) gives a translation as to the line location of the calling line, through the operated CB, CB1-5 relays. This is further checked in the CM, by checking the proper number of relays operated and if the correct number of relays are operated, operates the RK1, RK2, and RK3 (line link location check) relays. The RK2 and RK3 progress punches are an indication of the line link location check. The calling line location is registered on the FTT-, FUT-, VGT-, HGT- and VFT- relays. The FTT- and FUT- relays in operating select the LL. The VGT- and the HGT- relays then operate the associated VGB- and HG- relays in the LL. The HG- relay in operating closes through the LB- and LL test leads for testing the LL, and closes through the SM- leads to operate the LL select magnet. The VGB- and the HG- relays operate the associated LG- relay in the LL. The operation of the LG- relay closes through the LG- leads to the VFT- relay for controlling the operation of the proper LL hold magnet.

C4-2 LINE LINK FRAME SEIZURE (SFD-C402, C404, C405)

On SOG calls the seizure of the LL is made after the TL has been selected. The CK punch is an indication that a proper TL selection has been made. The LFS battery from the CM is applied to the LL-ST lead through the operated LLC2, TFK2, SOG1, FUT- and FTT- relays in the CM to the ST- lead of the LLC-PC circuit to operate the MP- relay and associated LLC multicontact relays. The LFK punch is an indication that all LLC relays have properly operated.

C4-2.1 PREFERENCE CONTROL CIRCUIT

The preference control associated with LLC provides two preference relays, MP- (marker preference) and E- (emergency marker preference) per marker for each LLC. There is a means for detecting trouble associated with both the MP- and the E- relays and for automatically switching from one to the other in the event of detected trouble. The MP- relays are interconnected by two chain circuits, which enable connections of one marker at a time to an LL frame. Similar independent chains interconnect the E- relays. While the following description is for MP- relays, it applies equally to E- relays.

C4-2.1.1 MP- Relay Operate Chain

In periods of very light traffic (assuming only one marker at a time applies start battery to bid for seizure of a LL), MP- relay operation is straightforward. Start signal battery from a marker is applied to the associated MP- relay winding which is connected through the MP- operated chain to ground at the winding of the first relay in the operate chain. In periods of heavy traffic two or more markers may initiate requests either simultaneously or in rapid succession.

Assume that the first CM and the first DTM initiate simultaneous request (apply start battery) for connection to the same LL. Both MP- relays will operate and lock. If, however, the first DTM had initiated a request slightly before the first CM, the MP- relay for the first CM would not have operated because ground for its winding could have been opened by the operated chain at the MP- relay for the first DTM. On the other hand, if the first CM initiated a bid first, any other marker ahead of it in the operate chain can subsequently operate its MP- relay.

C4-2.1.2 MP- Relay Work Chain

Since it is possible to operate two or more MP- relays at the same time, a work chain determines which MP- relay does the work. The work chain progresses through contacts of the MP- relays in the opposite direction to the operate chain starting with ground at a contact of the MP- relay for the first CM. If the MP- relay for the first CM is operated, the work chain ground will operate the M- LLC relay whether or not other MP- relays are operated. The M- relay operates other M- relays in the connector by closing through battery supplied by the marker.

When the marker which has seized the LL has finished its work and opened the start lead to the PC, its MP- relay is released. If there are any other operated MP- relays, the next MP- relay in the work chain which is operated, now functions as just described. This continues until all operated MP- relays have been served.

C4-2.1.3 Emergency Transfer

Two sets of preference relays MP- and E- are provided in the preference control either of which can perform the preference job while the other serves as a standby. The CH relay provides trouble detection on the active set of preference relays by monitoring the operate chain and one of the work chains. Assume that the TR key and TR relay are normal so that MP relays are active. When all MP relays are normal, ground through all the break contacts of the operate chain is connected to one side of the CH relay winding and ground through all the break contacts of the work chain which operated connector relays is connected to the other. The CH relay cannot operate with ground on both sides of its winding. When one or more of the MP- relays operate, both preference chains are opened to remove ground from both sides of the CH relay winding leaving resistance battery connected to both sides of the winding. Again, the relay cannot operate. If, however, all break contacts of either chain do not conduct, or if a wire is broken when the MP relays are all normal, one side of the CH relay winding will have ground, and the other will have resistance battery which will operate the CH relay. Also, if any of the break contacts fail to open, or if there is a false ground on either chain when one or more MP- relays operate, the CH relay will again have resistance battery on one side of its winding and ground on the other, and will operate.

If the CH relay operates even momentarily, the TR relay operates and locks. The TR relay operates TR- relays which transfer the SF, CK- and MC- leads from the MP- relays to E- relays. The TR relay also brings in a minor alarm and lights a CH lamp.

The alarm can be restored by momentarily operating the AR key located at the frame or can be restored remotely via the alarm sending circuit. Release of the alarm also restores operation to the MP- chain if the TR key is normal or to the E- chain if the TR key is operated.

C4-2.1.4 Manual Transfer

By operating the TR key the preference control can be manually transferred for the MP- to the E- relays. The TR key operates the TR- relays which remain operated to accomplish the transfer as described previously. The TR key also connects the CH relay to chains of the E- relays. If the CH relay operates, it operates the TR relay which locks and releases the TR- relays to transfer preference back to the MP- relays.

C4-3 CLASS-OF-SERVICE IDENTIFICATION

Originally, No. 5 crossbar was arranged for a maximum of 30 classes of service, wherein the CM received class of service from the ground extended through the LL on 1/30 leads. Later, two more leads (CGA and

CGB) were added to increase the number of classes to 60. In this case one out of the original 30, and one of the added two leads were grounded to provide two groups of 30. Still later the present standard arrangement was substituted. This arrangement grounds one of the first 10 leads CS0-9 as class tens and one of the second 10 leads CS10-19 as class units, thus using 20 leads to provide 100 classes of service. The third group of 10 leads CS20-29 and the CGA and CGB leads are used to provide 20 rate treatment classes.

In a very few offices the original 30 class-of-service arrangement was modified to provide 20 classes of service and 20 rate treatment classes (using the first 20 leads CS0-19 on a 1/20 basis for class of service and using the CS20-29 and CGA, CGB leads to provide two groups of 10 rate treatment classes).

The 20, 30, and 60 class-of-service arrangements are basically the same and are shown on SFD-C406. The tens and units class of service and rate treatment arrangement for a maximum of 100 classes of service is shown on SFD-C407.

C4-3.1 LINE LINK FRAME CROSS-CONNECTIONS

The right side of SFD-C406, C407 shows the cross-connections required for various classes of service and rate treatment arrangements.

C4-3.1.1 30 Classes of Service - Identification by Vertical File

When the FTK1 relay of the CM operates as a check of vertical file identification (SFD-C403), it closes the V-lead to ground a V- terminal in the LL (SFD-C406). This is cross-connected to a CS0-29 terminal in the LL frame. The CS0-29 leads are extended through LLC to the CM CS0-29 terminals, and to the MTFC to produce the trouble recorder punches CS0-29. The CS0-29 terminals in the CM are also cross-connected to the following terminals CN (coin), MR (message register), or AOC (all other classes). See SFD-C406 Note 1 for trouble card perforation on 1/x or 2/x basis.

C4-3.1.2 60 Classes of Service - Identification by Vertical File

The previous description applies also for 60 classes of service except there is an additional cross-connection from the VC- terminal of the LL to either the CA or CB terminal instead of to the ground terminal. The ground to operate the VGB0-11 (SFD-C406) originates through the normal MT11 relay contact and is extended to the LL via the CGA and CGB leads.

C4-3.1.3 20 Classes of Service-Rate Treatment-Identification by Vertical File

The description for 30 classes of service (SCD-C4-3.1.1) applies for rate treatment except that only leads CS0-19 are used for the 20 classes.

Leads CS20-29 are used for rate treatment as indicated on SFD-C406. Cross-connections in the LL provide this information. The VR0-4 cross-connection terminals are cross-connected to class-of-service terminals 20-29 and terminals VRG0-4 are cross-connected to class-of-service terminals CA and CB to give 20 possible rate treatments. The CS 20-29 leads give the units digit of the rate treatment number and the CA or CB leads give the tens digit.

C4-3.1.4 100 Classes of Service - Identification by Vertical File

The 100 classes-of-service arrangement is the standard and is now used even though equipment is not necessarily provided for the maximum of 100 classes.

When the FTK1 relay of the CM operates as a check of vertical file identification (SFD-C403) it closes the V0-4 lead to ground several terminals in parallel through diodes to prevent backup of ground from one terminal to another. Since class indications from the LL is on a tens and unit basis, two cross-connections are required. VT0-4 is cross-connected to CS0-9 to cause one of the relays CST0-9 to operate for class-of-service tens. VU0-4 is cross-connected to CS10-19 to cause one of the relays CSU0-9 to operate for class-of-service units.

Where rate treatment is provided, VR0-4, is cross-connected to CS 20-29 for rate units indication. The VRG0-4 is cross-connected to CA or CB for rate tens indication.

C4-3.1.5 Identification of Class of Service by Hold Magnet (SFD-C406, C407)

Where identification of class of service is provided on an individual hold magnet basis rather than on a vertical file basis, the V0-4 or VU0-4 terminal is cross-connected to the VFA, VFB or VFC terminal to operate a VFA, B or C relay. The HMC- terminal is cross-connected to a CS0-29 terminal for 30 or 60 classes, to CS0-19 for 20 classes or to CS10-19 for 100 classes. This method is used with line link pad control on line link pulsing only.

If rate treatment is provided, it may also be identified on a hold magnet basis where class of service is so identified by cross-connecting from HMR0-9 to CS20-29.

C4-4 CONTROL OF CLASS OF SERVICE BY MASTER TEST CONTROL (SFD-C406, C407)

Because offices may be equipped with any of several class-of-service and rate treatment arrangements, there are necessarily a number of optional arrangements provided in the MTC for controlling class of service and

rate treatment. On an OR class of test when the keys or switches for selecting class of service and rate treatment are in normal or off position, the CM functions as on a service call to obtain the class of service (and rate treatment is provided) from cross-connections in the LL. The ground from the marker which is normally steered through LL cross-connections is, instead, steered through class-of-service and rate treatment keys of the MTC. Use of these keys to control class of service is intended for use on OR class of test, so that any desired class of service may be set in the DTM for subsequent transfer to the OR.

C4-4.1 30 OR 60 CLASSES OF SERVICE (SFD-C406)

On test calls, the MT27 relay in the CM is operated. This opens the normal path through which the CM supplies ground over a V-lead to the LL to determine class of service from cross-connections in the LL.

When the CST- keys or CST switch are in the off position, the KCS0, 1 and 2 relays are normal and bridge the M27 relay break-contact in the CM to permit normal determination of class of service from cross-connections in the LL.

When the CST- key or the CST switch is operated to 0, 1 or 2 on an OR class of test, the KCS0, 1 or 2 relay, respectively, is operated. When the FTK1 relay operates, ground via the CSG2 lead is steered through an operated KCS- relay contact and through an operated CSU- key or the CSU switch in position 0-9 and again through contacts of an operated KCS- relay to one of the CS0-29 leads corresponding to the keys or key and switch operated.

C4-4.2 60 CLASSES OF SERVICE (SFD-C406)

When there are 60 classes of service, in addition to the control described above, the MT11 relay is operated on marker test calls and connects the CGA and CGB leads in control of the KCSA relay.

C4-4.3 20 CLASSES OF SERVICE WITH RATE TREATMENT (SFD-C406)

This is a feature provided in very few offices. Class-of-service functions as previously described for classes 0-19. The CST2 key or the 2 position of the CST switch is disabled. Instead, keys CRU0-9 or the CRU switch are provided.

To control class-of-service and rate treatment settings in the marker, the CST- keys or CST switch, the CSU- keys or switch, the CRU- keys or CRU switch, and the CSGA/B keys must be set as required.

C4-4.4 100 CLASSES OF SERVICE (SFD-C407)

On test calls, the MT27 relay in the CM is operated. This opens the normal path over which the CM supplies ground over a V- lead to the LL to determine class of service from cross-connections in the LL. When the CST- keys or CST switch, the CSU- keys or CSU switch, and the CRU- keys or CRU switch are in the normal or off position, the KCS0 1 and 2 relays are normal. This bridges the MT27 contacts in the CM to permit normal determination of class of service and rate treatment from cross-connections in the LL.

To control the setting of class of service and rate treatment in the CM, the CST- keys or CST switch, CSU- keys or CSU switch and, if provided, the CRU- keys or CRU switch should be set as desired. This operates the KCS0, 1 and 2 relays to extend the CSG2 lead ground to one out of ten of the CS0-9, CS10-19 to operate a CST- and CSU- relay, respectively, in the CM. When rate treatment is provided, the CSGA or CSGB key should also be operated.

C4-5 LINE LINK FRAME LOCKOUT

When a LL has seized a DTM via its LLMC, it is possible that a CM may seize the LL via its LLC before the DTM can seize the LLC. If the CM is setting up a connection from a calling line to a trunk, it must release the connection already established from that line to an OR before it can set up a new connection from that line to a trunk. When this occurs, the L relay for that line reoperates momentarily. The DTM must be prevented from attempting to identify this operated relay as a request for dial tone. If a CM has connected to a LL before there is a request for dial tone in the LL, the LL is prevented from requesting a DTM until the CM has released the LLC.

C4-5.1 SEIZURE OF DTM VIA LLMC BEFORE CM SEIZES LLC (SFD-C408)

If a LL has connected to a DTM via a LLMC but a CM connects to the same LL via a LLC before the DTM does, the DTM is not permitted to proceed with horizontal group selection until the CM completed its use of the LLC.

Whenever any VGS-relay operates in a LL, it operates the DT relay (SFD-C408) as an indication that there is a request for dial tone. If a CM seizes the LLC for that LL to establish a connection from a calling line to a trunk, its CB2 relay will be operated. The CB2 relay operates the LOT relay (SFD-C408). When the CM proceeds to the point of operation of the TCHK relay, it grounds the G lead toward the LL via the LLC. If the DT relay is operated in the LL, the ground is extended over the DTK lead

to operate the DTK relay in both the CM and the DTM. Operation of the DTK in the DTM opens the operate path of the HGG- relay (SFD-C408) on first trial calls. This prevents horizontal group selection, if not already completed, by the DTM until the CM has released the LLC.

The release of the HGG relay opens the HGT- leads (SFD-B109) preventing horizontal group selection. If, however, horizontal group selection had been completed before the DTK relay operates, the HGG relay would have already been released by the operation of the HGK relay and the operation of the DTK relay would have no effect.

C4-5.1.2 Seizure of LLC by CM Before There is a Request for Dial Tone in the LL

If a completing marker, setting up a connection from a calling line to a trunk, seizes a LLC and has proceeded to operation of its TCHK relay before a request for dial tone has operated the DT relay in the LL, the LL is prevented from requesting a connection to a DTM until the CM has released the LLC.

When the CB2 relay of the CM operates, it operates the LOT relay (SFD-C408). When the TCHK relay operates, ground on the G lead through the normal DT relay in the LL operates the LO relay in the LL. The LO relay operated opens start battery to the MSA and MSB terminals (SFD-B102) preventing a request for a DTM. Operation of the LO relay also prevents operation of the TM and TM1 relay when a VGS- relay operates, so that the TM timer (SFD-C408) does not start until the LO relay releases.

C4-6 LINE LINK FRAME CONTROL NON PAIRED OPERATION (SFD-C409)

The marker obtains access to the LL frame through the preference control and make-busy circuit and LLC circuit.

The marker will place HGB resistance battery on the HG- lead corresponding to the horizontal group number which it obtained from the register. The operation of the MA1 relay in the LLC will extend the HG- lead to operate the HGA- and HGB- relays in the LL.

The marker will place VGB resistance battery on the VGB- lead corresponding to the vertical group number which it obtained from the register. The operation of the MA1 relay in the LLC will extend the VGB- lead to operate the VGB- relay in the LL.

With HGA, HGB- and VGB relays operated, a path is closed from the LG- relay to the BS lead. However, the BS lead does not have battery connected to it by the marker until the marker receives ground on the HGK lead. The purpose of this is to insure closing the operating current of

the LG- relay in the marker rather than through the HGA-, HGB- or VGB- relay contacts so that protection can be provided on the basis of one per frame instead of one per LG- relay. The VGB- relay will operate before the closure of lead BS occurs.

C4-6.1 CROSS-DETECTION (SFD-C409)

The marker employs the operate test to detect trouble on the HGA-, HGB-, LG- or VGB- relays in the LL. If, for some reason, more than one HGA- or HGB- relay operated in the LL the XHG relay would operate in the marker. This condition would stop progress of the call. The HGK punch would not be present on a trouble card.

If, for some reason, more than one LG- relay operated in the LL the XLG relay would operate in the marker. The operation of the XLG relay would produce the XLG trouble punch.

If, for some reason, more than one VGB- relay operated in the LL the XVGB relay would operate in the marker. The operation of the XVGB relay would extend ground to operate the XAVG relay in the marker and produce the XVGB trouble punch.

C4-7 PAIRED LINE LINK FRAMES

Paired line link operation is possible on all types of linkage except dial tone. Before paired line link operation can be applied to a marker group, the junctor groups must be wired as one of the following sizes; 60LL-30TL, 40LL-20TL, 20LL-10TL.

An auxiliary LL frame consists primarily of ten 200-point crossbar switches split into right and left halves. The verticals of the right half are multiplied to the junctor switch verticals of the even-numbered line link frame while the horizontals serving these verticals become an extension of the line links of the odd LL frame. A similar transposed appearance of even frame links and odd frame junctors exist on the left half. In effect, linkage is provided from the line switches of one line link frame to the junctor of its mate.

C4-7.1 PAIRED LL FRAME AUXILIARY LL FRAME IDENTIFICATION (SFD-C410)

In a particular office, the marker recognizes a paired line link frame by the presence of solid ground on the LFK lead when the associated line link connector is operated. This ground operates the marginal PRL and LFKA relays. The LFKA in turn operates the LFK relay. A nonpaired LL frame will have resistance ground on its LFK lead, in which case only the LFKA relay operates. Relay LFKA operated, operates the LFK relay and marker operation continues.

Relay PRL operated, operates the PRL relay and also operates the PRLA relay (if provided). These relays have no effect until such time that a channel test is made. With the 10TLF relay operated, and no channels available, the operate path for the FMP relay is diverted by the PRL relay to the STP relay. Relay STP operated, with the sequential release of GC relay and operation of STP3 relay initiates the junctor step. Subsequently, STP1 relay releases, relay STP2 operates. Relay JG0 releases and JG1 relay operates.

C4-7.2 PAIRED LINE LINK FRAME MATE SEIZURE (SFD-C410)

Relay STP3 operated with PRL relay operated and MFK relay normal operates the STPA relay. Relay STPA operated locks around the contact of MFK relay, and places resistance battery on the MPP lead toward the LLC. This MPP lead connects to the MPP relay in the line link preference control circuit of the mate LL frame.

Relay MPP operated has two features:

- (a) It closes its contact in the work preference control circuit in order to seize the auxiliary LL frame when preference is gained.
- (b) It closes solid ground toward the LLC for the LL frame associated with that preference control circuit. If this particular LL frame should have its connector closed to some other marker, solid ground on the MFK lead will operate the MFK and MFL relays in that marker, opening the operate path for the STPA relay and preventing that marker from attempting mate operation.

When preference is gained in the mate LL frame preference control circuit, the auxiliary LL frame associated with this pair of LL frames is seized. Relays operate in this frame to cut through the select magnet leads from the LL frame to the select magnets of the auxiliary frame junctor switches. The choice of select magnets will be controlled by the horizontal group relays in the LL frame, and will correspond to those select magnets that can be chosen on the LL frame junctor switch.

Seizure of the auxiliary LL frame will transmit resistance ground on the MFK lead through the connector in the marker. Relay MFK alone operates and with STPA relay operated, completes the operate path for the TK relay.

During this time, the STP2 and JG1 relays, in combination with the PRL and PRLA relays operated, have selected the opposite half of the trunk switch, and reoperated those relays, such as the PNR, pattern normal relay, in the junctor step and control circuits in preparation for channel test. With the operation of the TK relay, channel test is again made.

C4-7.3 PAIRED LINE LINK FRAME AUXILIARY LINE LINK CONTROL
(SFD-C411)

When the MPP relay operates it places ground, on the LV lead to the auxiliary LL frame, through the operated HGB- relays of the LL frame. This ground will operate a LV- relay and a EV- or ODD- relay in the auxiliary LL frame. The numerical designation of the LV- relay operated will be the same as the HG- relay operated in the LL.

The operation of the LV- relay and the EV- or ODD- relay will parallel the select magnets on the auxiliary LL frame with the select magnets on the original LL frame. The operation of the EV or ODD relay will close a resistance ground to the marker over the MFK lead as an indication of mate frame lockout and select magnet cut-through.

C4-8 PAIRED LINE LINK FRAME - MARKER GLARE CONDITION (SFD-C410)

There is a possibility that two markers could have simultaneous calls to mated LL frames. As described previously, the marker expects a resistance ground on the MFK lead as an indication that the MPP relay has the work preference in the preference control circuit. If there is another marker in the mate LL frame also attempting a mate frame lockout, both markers would receive direct rather than resistance ground on the MFK lead. Both markers would recognize direct ground on the MFK lead as a glare condition and set the trunk to overflow.

C4-9 PAIRED LINE LINK FRAME AUXILIARY LINE LINK-MAKE BUSY
(SFD-C410)

The auxiliary LL frame is made busy by inserting make-busy plugs into both the MBO and the MBE jacks. A make-busy plug in either the MBO or MBE jack will indicate to the marker, when it is attached to the LLC, that the LL is nonpaired rather than paired.

SECTION C, PART 5

CHANNEL SELECTION AND HOLD MAGNET OPERATION

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C5 NETWORK CONNECTIONS

Following hold magnet operation, the channel is checked for crosses, continuity and double connections. The sender and trunk information is checked to insure its proper transmission (SFD-C502, 503).

Connections between a line and a trunk are made by closing the line switch and junctor switch crosspoints on the LL, and the trunk switch and junctor switch crosspoints on the TL.

The select magnets and hold magnets involved in closing the specific crosspoints depend on the location of the line on the line switch and the trunk on the trunk switch, and on the channel selected.

C5-1 CHANNEL ARRANGEMENTS

A channel is made up of a line link, a junctor and a trunk link, which are tested, selected and treated as a unit when establishing a connection between a line and a trunk or between two trunks.

The line links consist of the line switch banjo wiring, the line junctor switch banjo wiring, and the wiring between these switches.

The trunk links consist of the trunk switch vertical unit, the trunk junctor switch vertical unit, and the wiring between the two switches.

The juncctors consist of the line junctor switch vertical unit, the trunk junctor switch banjo wiring, and the wiring between the line junctor and trunk junctor switches.

The marker in selecting a channel, tests a maximum of ten channels at a time. The CHT- (channel test) relay tests a line link, a junctor, and a trunk link with numbers corresponding to the CHT- relay numbers. These tests are made simultaneously. Ground on any of the test leads operates a CHT- relay to indicate a busy channel. The channel number corresponds to the junctor switch number 0-9 on both the LL and the TL, the horizontal level 0-9 on the LL line switch, and the vertical number of the trunk switch on the TL.

C5-1.1 JUNCCTOR SEQUENCE CONTROL (SFD-C506, 507)

The number of juncctors in a junctor group may vary from a maximum of fifty juncctors to a minimum of ten juncctors. Since the marker is equipped to simultaneously test a maximum of ten channels and, therefore, to test a maximum of ten juncctors, each junctor group is subdivided into junctor subgroups consisting of ten or less juncctors. The marker selects those juncctors within one junctor subgroup when testing for an idle channel. The selection of the subgroup of ten or less juncctors is, in general, determined by the following factors:

- (a) The number of TLs in the marker group as indicated by the 2-10 TLF relays.
- (b) The LL number.
- (c) The junctor sequence position JSQ 0-5 which is used to equalize and rotate the traffic among the subgroups.
- (d) The junctor step STP1/2 position.

The selected subgroup of junctors is assigned to the ten channels so that the numerical designation of the junctor switch on both the LL and the TL to which the junctor connects is also the numerical designation of the channel of which the junctor is a part.

The junctor sequence walking circuit is shown on SFD-C507. A sequence chart showing the advance of the walking circuit on successive calls is shown on SFD-C506.

In the beginning of the call when the CKG4 relay operates, CKG4 in turn operates the LLC1,2 (Line Link Control) relays. If the sequence circuit is in an even position (JSQ0,2 or 4 and JLO operated), the LLC2 relay operates the JSQ relay which locks. When the LLC2 relay releases at the end of the call, the next higher numbered odd JSQ- relay operates, and, in turn, operates the JLE relay. The JLE relay releases the JSQ-, JLO and JSQ relays. Similar operation occurs when stepping from an odd to an even JSQ relay.

Six steps of control for preference circuits are provided by the JSQ 0-5 relays. This number is doubled by the operation of the SQ0 and SQ1 relays. If the SQ1 relay is normal when the JSQ0 relay operates, the SQ0 relay operates. If the SQ1 relay is operated when the JSQ0 relay operates, the SQ0 relay releases. Similarly, the SQ1 relay is operated or released depending on the condition of the SQ0 relay when the JSQ2 relay operates. The SQ0 relay is operated for one complete cycle of the walking circuit, then released for one complete cycle. The same applies to the SQ1 relay. However, since the SQ0 is operated and released by JSQ0, and SQ1 is operated and released by JSQ2, there are steps during which SQ0 and SQ1 may both be operated or both released.

The SQA relay monitors operations of the junctor sequence walking circuit. If the SQA relay operates as a result of trouble in the walking circuit, it operates the MXT (master cross test) relay which causes a trouble record to be produced showing an SQA trouble punch.

The following conditions cause operation of the SQA relay which is a slow operate relay to prevent false operation due to momentary closures as relays change conditions. The SQA relay operates the MXT relay which operates the TR1 relay to cause a trouble record to be taken showing an MXT and an SQA punch. The MXT is not shown on a single-sided card.

Trouble conditions detected between calls (LLC2-normal) occur when:

- (a) Both JLE and JLO are normal
- (b) Both JLO and JSO are operated
- (c) Both JLE and JSE are operated

Trouble conditions detected during calls (LLC2 operated) occur when:

- (a) JLO is operated and JSO is normal
- (b) JLE is operated and JSE is normal
- (c) SQ0 and SQ1 are both operated or both are normal when JSQ1 is operated
- (d) SQ0 is operated and SQ1 is normal or SQ0 is normal and SQ1 is operated when JSQ1 is operated

When the fuse which supplies battery to the walking circuit is inserted, the SQA relay will operate because the JLE and JLO relays are both normal. When the SQA relay operates, it operates the JSQ0 relay which operates the JLO relay which should release the SQA relay if there is no trouble in the walking circuit. This will cause a trouble record to be taken which will show an MXT punch, but no SQA punch unless the SQA remains operated because of trouble. The MXT is not shown on a single-sided card.

C5-1.1.1 Control of Junctor Sequence by Master Test Control
(SFD-C507)

With one of the JSQ0-5 keys or switches operated and the KCH relay operated, the MT8 relay of the marker is operated after the master test frame connector has operated the MT relay of the marker. The MT8 relay of the marker operated, releases the operated JSQ0-5 relay of the marker by opening its locking circuit. The released JSQ- relay releases the JLE or JLO relay of the marker and the released JLE or JLO in turn operates the KJSQ relay. The KJSQ relay closes ground from a back contact of the MT8K relay through the operated JSQ0-5 key or switch to operate the corresponding JSQ0-5 relay of the marker. This operates the JLE or JLO relay of the marker which removes ground from the KJSQ lead to release the MT8 relay of the marker whose operate path has been transferred to the KJSQ lead by the KJSQ relay of the test circuit when it operated and locked to ground on the KCH relay operated. The MT8 relay normal, closes the MT8K lead to operate the MT8K relay of the test circuit. The MT8K relay operated, locks to the KCH relay, removes ground from the JSQ0-5 lead, and extends ground to operate the MC relay. With all JSQ0-5 keys normal or the switch in the off position, or with the KCH relay normal the junctor sequence relays of the marker function in a normal manner.

If no JSQ0-5 key or switch is operated, the MTF lead to the marker is open and the MT8K lead is closed to the MC relay through normal contacts of the JSQ0-5 key or switch. The KCH relay normal bridges the MT8K lead around contacts of the JSQ0-5 keys or switches.

C5-1.2 OFFICE SIZE TRUNK LINK FRAMES (SFD-C507)

A cross-connection in each CM from the SZD terminal to one of the terminals SZ2-10 indicates the size of the office in terms of the number of single trunk link frames in a nonpaired office, number of pairs of trunk link frames in a paired office, or number of trunk link frame triples in a triple office.

During transition from one size office to another, some trunk link frames may have a junctor pattern for one size office while others have a different size office junctor pattern. In this case, the SZA, SZB and SZC terminals are cross-connected to appropriate SZ2-10 terminals in each marker, and the G terminal of each trunk link frame is cross-connected to SZA, SZB or SZC terminals as required. These cross-connections are changed in individual trunk link frames as the transition progresses. Upon completion of the transition, the SZD terminal of each CM is cross-connected to the SZ2-10 terminal corresponding to the new office size.

C5-1.3 SINGLE PAIRED OR TRIPLE TRUNK LINK FRAME OPERATION (SFD-C510)

A cross-connection in each CM from the SPF terminal to the SF, PR, or TTF terminal indicates to the CM whether the office is arranged for single, paired, or triple trunk link frame operation. During transitions, however, from single to paired, or paired to triple-trunk link frame operation, the marker cross-connections are removed and cross-connections are made in each TLC. A frame which has not been modified might be cross-connected as a STF (single trunk link frame) while another frame which has been modified might be cross-connected as a PR (paired trunk link frame).

C5-1.4 OFFICE SIZE LINE LINK FRAMES (SFD-C510)

The marker determines office size in terms of number of line link frames from a combination of the office size in terms of trunk link frames (SCD-C5-1.2) and the indication of single, paired, or triple trunk link frame operation (SCD-C5-1.3). The 20F relay operates for 1-20 line link frames, the 40F relay for 21-40 line link frames and the 60F relay for 41-60 line link frames.

C5-1.5 PATTERN UNITS (SFD-C504)

In the following size offices all junctor subgroups have 10 junctors.

2TLF Single, paired or triple.
2-3TLF Single, paired or triple.
5TLF Single, paired or triple.
10TLF Single, paired or triple.

All other sizes have some junctor subgroups with less than 10 junctors.

To determine which junctors are equipped, one P0-9 (pattern unit) relay is operated in the CM. The SFD-C504 shows how a particular pattern unit relay is operated for TLO in an office having single TL operation. It also shows particular pattern unit relay operation for either TL of TL pair 0 in an office having paired TL operation. Also shown is a particular pattern unit relay operation for any TL of TL triple 0 in an office having triple TL operation. The choice of a pattern unit relay is determined by the line link frame number (FUT0-9 relay and FTB0-3 relay operated) and the line link office size relay 20F, 40F, or 60F operated.

C5-1.6 NUMBER OF JUNCTOR SUBGROUPS (SFD-C508, C509)

This applies only to 6 TLF and 7 TLF size offices. Both of these office sizes have some junctor groups with two, and other junctor groups with three junctor subgroups. With either relay 6 TLF or 7 TLF operated, relays P0, 2, 3 and 4 operate the 3G (3 junctor subgroup) relay while relays P4-9 operate the 2G (2 junctor subgroup) relay.

C5-1.7 QUAD RELAYS (SFD-C510)

The 7Q (seven quad) relay is used only in paired or triple trunk link frame offices of the 7 TLF size. The RQ (regular quad) relay is used only in paired or triple trunk link frame offices of 6TLF, 8TLF or 9TLF sizes. The term "quad" no longer has a valid meaning since triple trunk link frame operation came into use. Essentially, these relays provide a convenient and more economical method of steering the JC- leads (SFD-C521) than by using contacts of TLF for a particular size offices.

C5-1.8 PATTERN TENS (SFD-C505)

The PNR relay is always operated by the following office sizes which have no subgroups of less than 10 junctors.

2TLF Single, paired or triple
2-3TLF Single, paired or triple

5TLF Single, paired or triple

10TLF Single, paired or triple

The PNR relay is also operated for certain other office sizes when the marker is directed by the operated or released condition of the STP1, STP2, and JSQ relays to junctor subgroups having 10 junctors. When the marker is directed to subgroups having less than 10 junctors, one of the pattern tens relays PA, PB, PC, or PE is operated.

C5-1.9 TEST CHANNEL RELAYS - TEST CHANNEL CHECK (SFD-C522, 525)

The marker determines which channels are equipped in a subgroup by operating one, two, etc. or all TCH-9 relays (SFD-C522). The PNR relay operates all ten TCH- relays. The combination of one pattern tens and one pattern units relay operates only those TCH- relays corresponding to equipped junctors.

The operation of any TCH relay operates the TCHK relay (SFD-C525) which locks to the operated CHA relay.

C5-1.10 JUNCTOR SUBGROUP SELECTION (SFD-C508, C509)

To simplify the path for operation of the JG relays, SFD-C508 shows operate paths for offices with 2, 2-3, 5, or 10 TLF-size while SFD-C509 shows operate paths for all other sizes 3, 4, 6, 7, 8, and 9. Note on SFD-C508 that only the JG0 relay can be operated for the 10TLF size since there is never more than one junctor subgroup. For the 5TLF size either JG0 or JG1 relay may be operated. For the 2-3TLF size, JG0 or JG3 relays may be operated. For the 2TLF size, JG0-JG4 relays may be operated. Since no pattern units relay is required for these office sizes, the 1-out-of-10 check of the P- relay is bypassed.

Office sizes 3, 4, 6, 7, 8, and 9TLF each have one or more junctor subgroups with less than 10 junctors and, therefore, must operate a pattern unit relay. Ground for operating the JG-relays is provided through a 1-out-of-10 check of pattern unit relays, and if the office has triple trunk link frames, a similar check through pattern auxiliary relays.

For any size office, the STP1 relay (SFD-C525) is always operated at the beginning of a call. If no idle channel is available in the junctor subgroup selected through the STP1 relay, the STP1 relay will be released and the STP2 relay operated to operate a different junctor subgroup, JG- relay. This applies to all sizes except 10TLF which has only one junctor subgroup.

The walking circuit is stepped to a new position at the end of each call for office sizes having more than one junctor subgroup. Different subgroups are given preference according to which JSQ0-5 and JLE or JLO relays are operated.

C5-1.11 JUNCTOR SUBGROUP CONNECTOR RELAYS (SFD-C525, C510)

The GC or GCA relay in some cases with triple trunk link frame operation (SFD-C525) operates early in the call from the LLC1 relay. The operated GC or GCA relay steers battery through contacts of an operated JG0-4 relay to operate a junctor subgroup connect relay G0-4 in the trunk link connector (SFD-C510). A one-out-of-five check through the JG0-4 relay ensures that only one relay is operated. To detect crossed G-leads to the TLC, normal JG- relays ground associated leads. If the lead associated with the operated JG- relay is crossed to any other lead, the direct ground causes sufficient current to flow through the XJG relay to operate it. The XJG relay is biased to not operate on the current required to operate the G- relay in the TLC. If the XJG relay operates, it in turn operates the XAJG relay which locks and causes a trouble record showing XJG punch to be taken.

C5-1.12 JUNCTOR CONNECT RELAYS - JUNCTOR CONNECT CHECK (SFD-C521, C527)

Junctor connect relays JC0-9 are associated with regular trunk junctor switches. Relays JC10-19 are associated with extension trunk junctor switches. Relays JC20-29 are associated with supplementary trunk junctor switches. The JC0-9 leads are partially closed by the previously operated G0-4 relays in the TLC.

The path for operating the JC- relays is shown on SFD-C521. Battery is supplied through the primary winding of the XJC relay so that the XJC relay is connected to ground through more than one JC relay winding. The XJC relay is biased through its secondary winding. If more than two JC leads are crossed or grounded, the current through the primary winding is sufficient to overcome the bias of the secondary and operate the XJC relay. When the XJC relay operates, it operates the XAJC relay which causes a trouble record showing a XJC punch.

When the G0 relay in the TLC is operated, JC0-9 leads from the marker are closed through directly to the JC0-9 leads, respectively, to the TL. However, relays G1-G4 close the JC0-9 leads from the marker to cross-connection terminals G10-19, G20-29, G30-39, and G40-49. The cross-connections required are different for each office size and vary between TLC associated with different TL in the same office.

To steer the activated JC lead to the proper JC0-9, JC10-19, or JC20-29 relays, the marker operates an RF, EF, or SEF relay (regular, extension, or supplementary extension frame, SFD-C520). Battery to operate one of these relays is fed through the winding of the XF relay which is biased to operate if the RF, EF, or SEF leads are grounded or crossed so that the XF relay supplies current to more than one relay. If the XF relay operates, it operates the XAF relay which causes a trouble record showing an XF punch.

The JC0 relay (SFD-C529) connects to the sleeve leads of the level 0 junctors on the left and the level 0 junctors on the right of each of the junctor switches 0-9. The JC0 relay also connects to ten different level 0 select magnets, one on each junctor switch 0-9. Similarly, each of the JC1-9 relays connect to sleeve leads and select magnets associated with levels 1-9, respectively, on each of the junctor switches 0-9. To associate with the junctors located on the right or left half of the switches, a marker operates R, ER, and SER relays or L, EL, and SEL relays (SFD-C520). The ER and EL relays (extension right and left) are required only for paired and tripled TL operation. The SER and SEL relays (supplementary extension right and left) are required only for triple TL frame operation. The battery to operate these relays is fed through the winding of the XLR relay. The XLR relay is biased to operate when connected to more than one relay, either L or R when the STF relay is operated for single TL frame offices. It is biased to operate when connected to more than three relays (R, ER, and SER, or L, EL, and SEL) when the STF and PR relays are normal in triple trunk link frame offices. It should be noted (SFD-C510) that during transitions STF or PR may be operated or nonoperated depending on which TLC is used. A TLC which has not been changed over from single to paired operation would still operate the STF relay while a TLC which had been modified would operate the PR relay.

When a JC relay operates, the JCK relay (SFD-C527) on the JS0 lead operates to ground through one of the select magnets on the 0 junctor switch as a check that the JC relay has operated. The JCK winding resistance, and JCK series resistance, limit current so that although the sensitive JCK relay operates, the select magnet does not operate.

When R, ER, and SER or L, EL, and SEL operate, the RK or LK (right check or left check SFD-C520) relay operates through contacts of all three relays in series as a check to the marker that they have operated.

C5-1.13 CONNECTION TO LINKS OF HORIZONTAL GROUP ON LINE LINK FRAME (SFD-C409, C524)

Operation of the HGA, HGB relays of the LL frame are shown on SFD-C409. Operation of these relays is checked by operation of the HGK relay of the CM. The operated HGB relay closes through LL0-9 leads to each of the ten links associated with that horizontal group (SFD-C524).

The selected group of ten line links is assigned to ten channels so that the numerical designation of the channel is identical with the numerical designation of the line link test lead LL0-9. The designation also agrees with the numerical designation of the junctor switch and the horizontal level of the line switch which are connected by the line link.

C5-1.14 CONNECTION TO LINKS OF TRUNK SWITCH ON TRUNK LINK FRAME
(SFD-C311, C529)

The selected trunk F relay controls the operation of the FA or FB relay in the TL (SFD-C311). Operation of the FA or FB operates the proper LV2-9 (level connector) and LC0-9 (link connector) relays in the TL for marker control of the select magnet operation, channel test, and hold magnet operation (SFD-C529). The A or B appearance and the horizontal level of the trunk switch is checked by the operation of the FAK or FBK relay in the marker (SFD-C311). To check that the LC relay operated, the LCK relay in the marker operates. The operated LC relay connects to sleeve leads of the links associated with the trunk switch on which the trunks appear (SFD-C529). The operated L or R relay closes through ten sleeve leads associated with the left or right half of the trunk switch (SFD-C529).

The selected group of ten trunk links are assigned to the channels so that the numerical designations of the channel of which the trunk link is a part is identical with the numerical designation of the trunk link test lead LH0-9, and with the numerical designation of the TL junctor switch to which the trunk link connects.

C5-1.15 CHANNEL TEST (SFD-C524)

Ten channel test relays CHT0-9 are connected through diodes to ten line link sleeves, ten junctor sleeves and ten trunk link sleeves (SFD-C524). Diodes in each lead prevent a ground on one leg of a channel such as a line link feeding through to another leg of the channel such as the junctor or trunk link while at the same time permitting a ground on the sleeve of any of the three legs to operate the associated CHT relay. The test paths for the 0 channel are shown in red on SFD-C524. The STX relay (SFD-C109) operates early in the call and provides direct battery to the CHT relay windings. Between calls the STX relay is released. If any of the channel test leads are falsely grounded to either the line or trunk link connectors, the XCH relay will operate between calls. The XCH relay operates the XACH relay which locks and causes a trouble record showing an XCH punch.

C5-1.16 TEST CHECK (SFD-C525)

The preceding paragraphs have described a number of operations which proceed at the same time in preparation for selection of a channel. Upon successful completion of each operation, a check relay operates. These check relays are summarized below.

TCHK - Checks that at least one TCH relay has operated.

JCK - Checks that a JC relay in the TL has operated.

RK/LK - Checks that a R or L relay in the TL has operated.

FAK/FBK - Checks that a FA/FB relay and an LV relay in the TL has operated.

LCK - Checks that a LC relay in the TL has operated.

HGK - Checks that a HGA and HGB relay in the LL has operated.

SCCK - Checks that originating class of service relays have operated.

SON - If SON relay is operated, indicating a sender required, ORK1 and 2 relays must be operated, indicating that the digit information to be transmitted has been received from the originating register.

When all of the above relays have operated, ground from the operated JCK relay operates the TK (test check) relay.

C5-1.17 SELECTION OF A CHANNEL (SFD-C525)

The LLC1, CHT, SLRK and CB5 relays will have operated early in the call. When the LOT and DTK (SFD-C408) relays operate, ground is closed to operate a CHO-9 relay. There is a double chain path composed of CHT0-9 relays and TCHO-9 relays to determine which CHO-9 relay, if any, is to be operated. Some or all of the TCH- relays (SFD-C522) will be operated as an indication of which channels are provided in the subgroup being tested. Any channel which is busy (SFD-C524) will have an operated CHT relay. If the TCHO relay is operated and the CHT0 relay is normal, the CHO relay operates and locks. If, however, either TCHO relay is normal or CHT0 relay is operated, ground is passed to operate the next relay in the chain which has an operated TCH relay and a normal CHT- relay. When one CH- relay has operated and all others are normal, the CHA relay operates as an indication that a channel has been selected.

C5-1.18 NO IDLE CHANNEL, RECYCLE, FAILURE TO MATCH, ROUTE ADVANCE (SFD-C525, C512, C513, C514, C515, C517, C519)

If there is no idle channel, that is, no CH- relay having both an operated TCH- relay and a normal CHT- relay (SFD-C525), the FMP relay operates in a 10TLF size office. In all other size offices, the STP relay operates. Refer to the flowchart (SFD-C512) and the sequence charts (SFD-C513, C514, C515) which show the general and detailed sequence of operations under various conditions.

The marker recycles when it is unable to find a channel between a line or trunk appearance on the LL and a trunk appearance on the TL. On recycles caused by failure to match, the marker makes a second attempt to complete the call by using trunks to another TL in the same route. The marker then tests the new group of channels to complete the call.

All office sizes except 10TL nonpaired, 20TL paired, or 30TL tripled have more than one subgroup of junctors. Since the marker can test only one subgroup of junctors at a time, facilities are provided to shift junctor subgroups if the marker finds all channels busy when testing the choice subgroup.

The STP operates when all available CHT0-9 relays are operated because all channels are busy. The operated STP releases the GC, and causes the marker to select another junctor subgroup.

If testing the second subgroup of junctors also results in an all channels busy indication, the operation of the CHT- will cause the FMP relay to operate.

The FMP causes the FM (failure to match) to operate and control the operation of two sets of counting relays. One set of counters (1F, 1FA, 2F and 2FA) counts the total failures to match, the RF, RFA counts the matching failures within a route.

Failures to match causes the following marker action:

1st failure causes recycle or allotter advance.

2nd failure within route causes route advance.

3rd failure causes route advance; register returns busy-tone.

Route advance occurs when the marker cannot find an idle channel. The R- (route) relays are divided into blocks with each block being wired to one of the GS- ground supply relays. Each GS- relay supplies ground to the contacts of the R- relays in the block.

The marker provides six ground supplies. Depending on the office involved, the route relays are assigned to the ground supplies to provide the required direct and alternative routing.

Ground supplies one through four are used for direct and alternate routes. Ground supply five is used for tone trunks. Ground supply six is used for common overflow trunks.

C5-1.19 ROUTE ADVANCE CONTROL BY MASTER TEST CONTROL (SFD-C516)

Route advance is controlled by an RAO-3 key (or RA switch, or RAU switch and RAT1 key) which is operated to cause the marker to route advance a number of times corresponding to the key operated or position of the switch, and to allow the marker to select a trunk link frame only after it has route advanced that number of times, but not after it has route advanced more than that number of times. The RA(1-11) lamps indicate the number of route advances.

C5-1.20 CONTROL OF CHANNEL SELECTION BY MASTER TEST CONTROL (SFD-C522, C523)

The marker can be directed to select a particular channel under control of the CH0-9 keys or switch, and to select a particular junctor step position under control of the STP1/STP2 key.

C5-1.20.1 Particular Channel Selection (SFD-C522, C523)

With the CH- keys or switch and the STP1/STP2 keys normal, there is no control of channel selection from the master test control circuit and a channel is selected at random as on a service call. With the CH- keys or switch operated, the MT7 relay in the marker operates. This opens the grounds normally used by the marker to operate TCH0-9 relays. The operated CH-key or switch provides ground on one of the TCH0-9 leads to permit the corresponding TCH0-9 relay to operate but only if it would normally have been operated by the combination of pattern relays operated. This procedure restricts the marker so that it can operate only a channel relay corresponding to the operated CH- key or switch. The CH- relay can be operated only if the channel is idle (as indicated by the corresponding CHT- relay normal).

If a particular channel is not available in STP1, the marker makes a retest to try to find a channel in STP2 (except in 10TLF, 20TLF and 30TLF size office) (SFD-C523). Again the marker is restricted to select only the channel corresponding to the operated CH- key or switch.

C5-1.20.2 Combined Particular Junctor Step and Channel Selection (SFD-C522)

When a STP1 or STP2 key and a CH- key or switch are operated together, the CM is restricted to selection of a particular channel within a particular junctor step. The MT7 relay of the CM remains operated in both Step 1 and Step 2. The STP relay of the MTC is operated during Step 1 with the STP1 key operated and during Step 2 with the STP2 key operated. This feeds ground through the operated CH- keys or switch to permit selection of only that channel corresponding to the operated CH-key or switch.

C5-2 SELECT MAGNET OPERATION

C5-2.1 LINE LINK FRAME SELECT MAGNET OPERATION (SFD-C526)

Upon operation of a CH- relay, battery through the LS and LSA resistance lamps is closed to the select magnets on the line link frame. This battery is steered by the operated HGA- relay to the proper link select magnets and junctor hold magnets. It should be remembered that the line junctor switches also serve as line switches. One-half of the verticals

is for junctions and the other half is for lines. If the CHO and HGAO relays are operated for a line on one of the number 0 line switches to a junction on the 0 junction switch, an LO and an LJO select magnet are operated. The LJO select magnet would serve a customer on the line side of the line junction switch. If the CH1 relay and HGAO relays are operated for a line on one of the number 1 line switches to a junction on the 0 junction switch, the LJ1 select magnet for the 0 junction switch would operate, but the LJO select magnet on the number 1 junction switch would also be operated to serve a line on the line side of the number 1 junction switch.

When paired LL frame operation is provided, the select magnet leads extend to the auxiliary LL frame. The XLS relay is connected to SM- leads through normal contacts of all but the operated CH- relay. If the SM- lead through the operated CH- relay is crossed to any of the other SM- leads, the XLS relay will operate to the applied battery and lock. The XLS relay operates the MXT relay which causes a trouble record to be taken showing an XLS punch.

C5-2.2 TRUNK LINK FRAME JUNCTION SELECT MAGNET OPERATION (SFD-C527)

Upon operation of a CH- relay, battery is closed to junction select magnets on the TL. The operated CH- relay closes an JS- lead to a junction switch of the same number as the CH- relay. An operated JC- relay on the TL closes the JS- lead to a select magnet of the same number as the last digit of the JC- relay. The JC0-9 relays are associated with the regular TL, the JC10-19 relays are associated with the extension TL, and JC20-29 are associated with the supplementary extension TL.

It should be noted that the JCK relay, which operated as a check that a JC- relay has operated, is released if the CHO relay operates to apply battery to the JS0 lead. For this reason, the JCK punch will not appear on trouble cards where channel 0 is shown.

Battery to the JS- leads is fed through the XJS relay which is biased to operate if it is connected to ground through more than one select magnet. If the XJS relay operates, it operates the XAJIS relay. The XAJIS relay operates the MXT relay which causes a trouble record to be taken showing an XJS punch.

C5-2.3 TRUNK LINK FRAME TRUNK SELECT MAGNET OPERATION (SFD-C527)

When the FAK or FBK relay in the marker operates, the battery is extended to the TL on the ASM or BSM lead. This battery is directed by the operated LV- and FA- or FB- relays in the TL to operate a select magnet on the A or B trunk switch steering level and on the level of the selected trunk. Ground for the trunk level select magnets is provided by the marker on the TSX lead. This ground is present upon the release of TSE1 relay immediately following the selection of an idle trunk.

After trunk selection, when the TSE1 relay has released and the FAK or FBK relay has operated, the XTS relay is connected to the TSX lead. The XTS relay is biased to operate if it is connected to battery through more than one T2-9 select magnet. If there is a cross which closes the ASM lead to more than one of the select magnets T2-9, the XTS relay operates and in turn operates the XATS relay which operates the MXT relay to cause a trouble record showing an XTS punch.

C5-3 HOLD MAGNET OPERATION-NETWORK AND LINE TEST

The sequence of hold magnet operation differs, depending on whether the marker determines that traffic is heavy or light. Under heavy traffic conditions all hold magnets are operated at the same time with a minimum of checks and tests to reduce marker holding time. Under light traffic condition, operation of the line hold magnet is delayed to permit a test of the talking path for crosses. After the line hold magnet has operated, a continuity test of the talking path crosspoints is made.

Headings of the following paragraphs are designated HTR, LTR or HTR/LTR as an indication that the paragraph applies only to heavy traffic, only to light traffic, or to either heavy or light traffic operation.

C5-3.1 DETERMINATION OF LIGHT OR HEAVY TRAFFIC BY CM-HTR/LTR

Hold magnet operation, as well as other marker functions, differ according to whether traffic is light or heavy. The CM determines whether the traffic is light or heavy by measuring the time between seizures of the CM using the HTT timer (SFD-C137).

At the beginning of a call, the MCB- relays of the CM are operated over the MB lead from the ORMC (SFD-C106). The MCB1 relay operated extends ground on the TM lead to operate the OAT relay. If the HTR relay is already operated from the last call it remains locked to ground through normal contacts of the HTT relay (SFD-C137). At the end of the call, the OAT relay releases. If the HTR relay is not already operated, it operates and locks releasing the OAT1 relay. With the OAT and OAT1 relays normal and the HTR relay operated, the shunt around the HTT capacitor (SFD-C137) is opened allowing the HTT capacitor to charge until the HTT tube fires and operates the HTT relay or until the CM is seized again and the OAT relay operates to stop the timing. If the time between calls is greater than 0.96 to 1.6 seconds, the HTT relay operates releasing the HTR relay so that the next call is handled on a light traffic basis. If the interval is shorter than 0.96 to 1.6 seconds, the HTR relay remains operated and the call is handled on a heavy traffic basis.

C5-3.2 HOLD MAGNET TIMING - HTR/LTR (SFD-C530)

As described in preceding paragraphs, select magnets are operated on line link and trunk link frames upon operation of a CH- relay. Operation of a CH- relay also operates the CHA relay which starts a hold magnet timing interval. This time interval is necessary to allow select magnets to operate, for select fingers to seat, and for any previously operated hold magnets connected to this channel to release before operating hold magnets for this call.

Prior to operation of the CHA relay, current flows through the primary winding of the HMT relay in a direction to operate it, while current through the secondary flows in a direction to release it. The combination of external resistance, winding resistance, and difference in number of turns is such that the current in the secondary prevents the HMT relay from operating. When the CHA relay operates, current in the secondary decreases as the HMT capacitor charges. When the effect of the current in the secondary becomes less than that of the current in the primary, the HMT relay operates. This operate time can be set at 43-50 ms by cross-connecting terminal HMT1 to HMT3 or to 63-75 ms by cross-connecting terminal HMT1 to HMT2. The longer time interval is required in offices which have some switches which are not equipped with damping cones, since the select fingers on these switches take longer to settle down. Operation of the HMT relay operates the HMT1 relay.

C5-3.3 CHECK OF CHANNEL - HTR/LTR

Early in the call, the SLRK relay operates (SFD-C531) from ground on the LLC3 relay through normal contacts of the following relays to ensure that they are initially normal: SLA, TGCK, JGCK, GLH1, GT2, HMT1 and CHA1. The SLRK locks when the TK relay operates. If the SLRK relay fails to operate, operation of a CH- relay (SFD-C525) is prevented.

In the process of channel test (SCD-C5-1.15, SFD-C524) busy channels are detected by looking for ground on sleeve leads. If ground is not detected on any of the three parts of a channel, it is presumed to be idle and one of the "idle" channels is selected by operation of a CH- relay (SFD-C525).

A further check of the channel is made after a CH- relay has operated. The JGCK and TGCK relays (SFD-C533) are connected to junctor and trunk hold magnet leads, respectively. These are high resistance sensitive relays which operate to battery on hold magnet windings without operating the hold magnets. This provides a positive check that the hold magnets associated with the channel are idle (ungrounded). A further check of the sleeve of the line link selected is made by the LLT relay. If the line link is idle (ungrounded) the LLT relay will not operate (SFD-C524).

C5-3.4 CROSS CHECK OF TRUNK SLEEVE - HTR/LTR

Prior to operation of the HMS1 relay, the XSL relay is connected to the AST or BST lead (SFD-C533) to detect any cross to ground. If the XSL relay operates, it locks and operates the MXT relay which causes a trouble record showing an XSL punch.

C5-3.5 HOLD MAGNET START - HTR/LTR, (SFD-C531)

With the HMT1, JGCK, TGCK, and SLRK relays operated, and other check relays released, the HMS1 relay operates to start hold magnet operation. The operation of the HMS1 relay closes circuits for operating the LL and TL hold magnets and the line hold magnet of the channel.

C5-3.6 HOLD MAGNET OPERATION - HTR/LTR (SFD-C533)

The operation of the HMS1 closes the operate circuit over the LH-, J-, and LH-(TL) leads to the LL and TL hold magnets of the selected channel. Relay HMS1 operated extends the +130 volts on the LH, JH-, and TH-capacitors to the winding of the hold magnets. The capacitors discharge through the hold magnets, causing them to operate. When the voltage across the capacitor drops to about -.5 volts the LH, JH-, and TH-diodes become forward biased and pass a steady current to hold the hold magnets operated.

The TL trunk and junctor hold magnets and the LL junctor hold magnet are always operated on a dual voltage basis.

C5-3.7 DUAL VOLTAGE OPERATION - HTR/LTR (SFD-C533)

With the standard dual voltage option, all hold magnets except the line hold magnet are operated by a high voltage surge on all calls. The line hold magnet is operated by the high voltage surge except on calls to message rate lines in offices having message registers. This is to avoid the possibility of falsely operating the message register. Lines equipped with message registers are indicated to the marker over the class-of-service leads from the LL. The class-of-service indication is received over the CS00-29 leads, which in turn are cross-connected to operate relay CNA (coinline auxiliary), AOA (all other auxiliary), MRA (message registers auxiliary), or CGS (centrex station). The operation of the CNA, AOA, or CGS relays operates the DVO relay, which in turn operates the DVA relay indicating that the marker should use dual voltage to operate the line hold magnet. The operation of the MRA indicates 48 volt operation for the line hold magnet.

With DVA or MRA operated and the HMT operated, ground is closed to operate the HMT1 relay.

C5-3.8 OPERATION OF LINE HOLD MAGNETS - HTR (SFD-C533)

Assume a heavy traffic call with a nonmessage rate line. Upon operation of the HMS1 relay, with the HTR, DVO and DVA relays operated, ground is

furnished through the primary winding of the LXP relay in series with the LH capacitor. The LH capacitor (which has previously been charged to +130 volts and acts momentarily like a 130 volt battery) is applied to the winding of the line hold magnet which is connected to -48 volt battery. The effect is as though a battery of 178 volts were connected to the relay winding. The voltage of the LH capacitor rapidly decreases to 0 and then to a fraction of a volt negative at which point the LH diode begins to conduct, so that the hold magnet is held operated to ground potential. Application of high voltage in this manner causes the hold magnet to operate in about 1/3 the time it would take if 48 rather than 178 volt operation were used.

If the DVO and DVA relays are normal, 48-volt operation is used. That is, the ground through the winding of the LXP relay is applied directly to the hold magnet without the LH capacitor in series.

With or without surge voltage operation, the LXP relay operates in series with the line hold magnet. The LXP relay operates the LXPA relay which locks (SFD-C531).

C5-3.9 OPERATION OF JUNCTOR AND TRUNK HOLD MAGNETS - HTR/LTR (SFD-C533, C531)

The HMS1 relay closes ground through the JXP relay primary winding in series with the JH capacitor charged to +130 volts over the J- lead to the winding of the line link junctor hold magnet.

The HMS1 relay also closes ground through the TXP, TXP1 resistance lamps in series with the TH1, 2 and 3 capacitors charged to +130 volts over the LH- lead to the trunk and trunk junctor hold magnets. As described for high voltage surge operation of line hold magnets, the magnets operate in about 1/3 of the time required for 48-volt operation. When the capacitor discharges, the magnets continue to be held operated through the diodes to ground through the JXP relay or the TXP, TXP1 resistance lamp. The JXP relay operates in series with the line junctor hold magnet and operates the JXPA relay which locks.

C5-3.10 CROSSPOINT CHECK - HTR/LTR (SFD-C533, C531, C524)

C5-3.10.1 Heavy Traffic

When the hold magnets have operated, the low resistance ground from the TXP, TXP1 resistance lamps operates the SL relay and releases the LXP and JXP relays which operate the LXP1 and JXP1 relays, respectively. The SL relay operates the SLA relay (SFD-C533). The LLT (SFD-C524) relay, which has previously operated when operation of the line junctor hold magnet grounded the line link sleeve, operates the LLTA relay. Operation of the SLA, LLTA, LXP1 and JXP1 relays closes ground through the previously operated HTR relay to operate the GT1 relay, which locks.

C5-3.10.2 Light Traffic

Crosspoint check on light traffic is the same as preceding, except:

- (a) Line hold magnet operation does not occur at the same time as operation of the other hold magnets when the HTR relay is not operated.
- (b) Operation of the SLA, LLTA and JXP1 relays closes ground through the normal HTR, LXPA and LXPI relay contacts to operate the LTR (light traffic) relay instead of the GT1 relay.

C5-3.11 FALSE CROSS AND GROUND TEST - LTR (SFD-C535)

On light traffic calls, a test for crosses on the network tip and ring conductors is made. For this reason, the operation of the line hold magnet operation is delayed during the test so that crosses or grounds external to the network are not detected.

Ground through the secondary, and battery through the primary windings of the FCG relay are connected to the ATT or BTT and ART or BRT leads, respectively.

The FCG relay will operate if there is a false ground on the ring conductor at any point from the nonoperated LL line hold magnet crosspoints to the primary winding of the FCG relay. If there is a false battery on the tip conductor at any point, the FCG is operated by current through the secondary winding. Or, if there is a false cross between the tip and ring conductors at any point, the FCG relay is operated by current through the primary and secondary windings. The operation of the FCG relay would stop the progress of the call and produce a trouble record showing the FCG punch.

When the LTR relay operates, indicating that all crosspoints other than those for the line hold magnet have closed, a locking ground is provided for the FCG relay in case it has operated. If the FCG relay has not operated, the GLH relay operates (SFD-C530).

The GLH relay disconnects the FCG relay from the ATT or BTT and ART or BRT leads and grounds both leads to discharge any voltage remaining on them from the FCG test.

C5-3.12 DELAYED OPERATION OF LINE HOLD MAGNET - LTR (SFD-C530)

The GLH relay operates the GLH1 relay. With the GLH1 relays operated, the line hold magnet is connected either in series with the LXP primary winding to ground (if the DVO and DVA relays are normal) or in series with the charged LH capacitor to ground through the LXP primary winding,

if the DVO and DVA relays are operated. The operated LXP relay operates the LXPA relay. When the line crosspoints close, the LXP relay is forced to release by ground from the TXP and TXPl resistance lamps. This operates the LXPl relay.

C5-3.13 CONTINUITY TEST, GENERAL - LTR (SFD-C535)

A continuity test of the talking path through the network is made on light traffic calls. In order to check continuity of the path through the network, a path from tip to ring conductors or from either tip or ring to ground external to the network is required. Twenty-cycle (AC-DC-AUD) ringing supply is stepped up to a higher voltage by the CON2 transformer. With the GLH1 relay normal, the output of the CON2 transformer is open-circuited. There is no current flowing and, therefore, no voltage buildup across the CON2 capacitor. When GLH1 relay operates (assume RCTA relay normal) the CON2 transformer is connected through the network to the ring side of the line. Ground is connected to the tip side. On nearly all calls, the off-hook status will be connected across the tip and ring so that there will be a relatively low dc resistance in the loop. Current will flow, causing an alternating voltage to appear across the CON2 capacitor. Terminal 1 of the CON tube is connected through the CON1 resistor to the CON2 capacitor. If the voltage at terminal 1 reaches the firing voltage of the CON tube, even momentarily, the CON tube fires and continues to conduct between terminals 2 and 4 to operate the CON relay even though the voltage at terminal 1 is no longer above the firing voltage.

Occasionally the station will go on-hook just before the continuity test is applied. If this is an individual line, the path through the ringer and the series capacitor allows sufficient 20-cycle (AC-DC-AUD) frequency current to flow to raise the voltage across the CON2 capacitor to the firing voltage. The same holds true for a ring party line. In this case, current flows through the network ring lead only through the ringer and capacitor to ground and back through the earth to the central office ground. If there is only a tip party connected to the line, insufficient current may flow and the CON tube may not fire at this time (still assuming that the RCTA relay is normal at the beginning of the continuity test.) As described in more detail later, the RCTA relay operates after a short interval to reverse the continuity test. Now, current flows through the tip lead through the tip party bell and capacitor, back through the earth to the central office ground. If the RCTA relay had been initially operated and only a ring party station had been connected, the RCTA relay would have released to apply the continuity test to the ring side of the line.

On long lines, the cable capacity is sufficient to satisfy the continuity test even if there is no other path through ringers or transmitter.

C5-3.13.1 Continuity Test Reversal Control - LTR (SFD-C535)

The RCTB relay operates from ground through the HTR relay contacts normal, and prevents the RCTA relay operation for ring party stations. On continuity test of a multiparty line, the ring side of the line is tested first. If the continuity test is satisfactory, the operation of the CON1 relay locks the RCTB relay operated. If the continuity test is not satisfactory, the RCTB relay releases when the LXP1 operates, and causes the RCTA relay to operate. The operated RCTA removes the continuity test from the ring and applies it to the tip conductor.

C5-3.13.2 Continuity Test Description - LTR (SFD-C535)

Operation of the GLH1 relay, in addition to starting operation of the line hold magnet, also starts the continuity test. Stepped up 20-cycle ringing supply voltage through the CON2 transformer in series with the CON2 capacitor to ground is applied to either the tip or to the ring of the path through the network depending on whether the RCTA relay is operated or normal. Ground is applied to the other side of the path through the network. The GLH1 relay also applied +130 volts to a voltage divider supplying the winding of the CON relay.

If there is continuity through the crosspoints and continuity external to the network, the voltage across the CON2 capacitor builds up sufficiently to fire the CON tube. The CON relay operates, in turn operating the CONA relay. The CONA relay operates the CON1 relay which locks. The CON1 relay closes a locking path to prevent release of the RCTB relay (if it has not already released), operates the GT1 relay which locks, and grounds the control terminal 1 of the CON tube. The GT1 relay removes positive battery from the CON relay allowing it to release. This, combined with the grounding of control terminal 1, extinguishes the CON tube.

The CON1 and CON3 capacitors are small and serve to prevent false firing of the CON tube from electrical noise pulses.

C5-3.13.3 Continuity Failure Trouble Record - LTR

If the CON tube fails to fire, the CON and CON1 relays do not operate, and the CM cannot proceed with the call. The work timer which is recycled upon operation of the GLH relay (SFD-C137) times out after 450 to 605 milliseconds. This causes a trouble record showing WT, GLH and all progress punches through the DCT (but does not include the CON punch).

C5-3.13.4 Cancel Continuity - LTR (SFD-C530, C531, C535)

On second trial calls, the operation of the GLH1 relay operates the CON1 relay from ground on the operated TR2C (SFD-C530), thus, automatically canceling the continuity test. On heavy traffic calls, operation of the LXP1 relay with the HTR relay operated (SFD-C531) operates the GT1 relay, thus, canceling continuity test by bypassing operation of both the CON and CON1 relays.

Continuity test can be cancelled on all calls for all markers by operating the CCT key at the master test frame jack lamp and key panel (SFD-C535).

C5-3.14 DOUBLE CONNECTION TEST - HTR/LTR (SFD-C533)

On both light and heavy traffic calls a double connection test is made to ensure that the sleeve of the connection being set up is not crossed with the sleeve of another connection already set up or in the process of being set up. Although operation of the line hold magnet is slightly delayed on light traffic calls, the double connection test is made in the same manner on both light and heavy traffic calls.

When the LXP1, JXP1 and SLA relays have all operated, as previously described, the LXP and JXP relays and the TXP and TXP1 resistance lamps are disconnected from respective leads to line and trunk link frames. At the same time the DCT relay is connected to the LH- lead to the line link frame. The DCT relay winding now provides the only ground from the CM to keep the hold magnets operated. Bias current through the secondary winding of the DCT relay is such that the DCT relay will operate if there is no other ground feeding the connection such as would occur if the sleeve path were crossed to an established network connection.

C5-3.14.1 Heavy Traffic

On a heavy traffic call the GT1 relay operates upon completion of the crosspoint check (SCD-C5-3.10.1). With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

C5-3.14.2 Light Traffic

On a light traffic call, the GT1 relay does not operate until the CON1 relay has operated as a result of a successful or cancelled continuity test. With the GT1 relay operated, operation of the DCT relay operates the DCT1 relay which locks.

C5-3.15 HOLD MAGNET SIMULATION AND CONTROL BY MTC (SFD-C532, C533)

On an originating class of marker test, it is desirable to be able to test the marker using any line location information. To avoid the possibility of having a customers line become locked into the test call if the line should happen to go off-hook during the progress of setting up the test connection, line hold magnet operation is simulated.

C5-3.15.1 NTC Key Normal

The MT11 relay of the CM is operated on test calls. This opens the path over the LH- lead (SFD-C533) to the line link frame which would normally be used to operate the line hold magnet on a service call. Instead, on a test call the path is extended over the LHMT lead to the MTC and

through the MKT2 relay to the LHM relay (NTC key and NTC1 relay normal) (SFD-C532). The LHM relay and the series LHM resistance are chosen to present an impedance to the marker equivalent to that of a line hold magnet.

When the HMS1 relay of the marker operates, the marker applies either the high voltage surge for dual voltage or ground through the winding of the LXP relay to operate the LHM relay of the MTC. The LHM relay operates the LHMA relay which extends the LHMT lead to the LLJ lead. The LLJ lead ties into the J lead of the CM to the trunk link frame at a point ahead of the CH- relay to simulate the path which would have been closed on a service call over the LH- relay lead to the LL, through the junctor and back over the J- lead to the CM. This permits the marker to go through all the motions of crosspoint and double connection checks. It will actually close junctor crosspoints on the LL, but checks are made through the simulated path just described. The CM operates and checks crosspoints on the TL in the normal manner.

C5-3.15.2 NTC Key Operated (SFD-C532, C533, and C537)

The NTC key of the MTC is operated on an originating class of test where it is desired to establish a connection and check the tip, ring and sleeve path through the line link frame using all crosspoints which would be used on a service call except the line hold magnet crosspoints. Use is made of the no test connector access to LL frames.

Operation of the NTC key on originating class of test operates the NTC and NTC1 relays. The operation of the NTC and NTC1 relays prepares the test circuit for operation with the no-test connector.

When the MTC gains access to the no test connector, the F1 relay of the MTC is operated over the SPC lead (SFD-C532). Operation of the F1 relay operates the NTC select magnets (associated with no test connector level assigned to the MTC) on all no test connector switches (see SFD-C537 as well as C533). The F1 relay also connects the NTB relay of the MTC to the no test connector via the NTH lead. The NTH lead is steered through the CM and the HGA- relay of the LL to the winding of the NTC hold magnet of the no test connector associated with the link to be simulated. If the NTC hold magnet is in use, ground on its winding will be fed back to operate the NTB relay of the MTC which locks on its secondary winding and lights an NTB lamp to indicate NO TEST BUSY. If this occurs, simulated hold magnet operation by the no test connector is blocked. The CM work timer times out and a trouble card showing LXPA but not LXPI would be produced followed by release.

If the NTC hold magnet is not in use, the NTB relay does not operate. Later in the call, when the CM grounds LHMT lead (which on a regular call would operate the line hold magnet), the NTH relay of the MTC is operated. The NTH relay extends ground from the NTB relay normal to the NTH lead to operate the NTC hold magnet of the no test connector, extends the LHMT lead to the S lead, and closes the tip and ring leads to the test circuit trunk appearance on the no-test connector (SFD-C535).

On an originating test the LK1 relay is operated through the operated MC7 relay (SFD-C604). The operated LK1 relay opens the H lead to the no-test connector to release the no-test connector hold magnet which opens the S lead and releases the NTH relay (SFD-C532). At the completion of the terminating stage the marker operates the SCB relay which recloses the H lead so that the no-test connector may be used again for the originating stage.

C5-3.15.3 Dual Voltage Test (SFD-C533)

When dual voltage operation is provided, the LHMT, LLJ and TLH relays of the MTC are connected to the LHMT, LLJ and TLH leads, respectively. If the CM applies the high positive voltage surge to each of these leads, the corresponding relays should operate to light the LHMT, LLJ and TLH lamps, respectively. Current through the lamps also locks the relays. Tests should be made using message register class of service, if provided, to ensure that the high voltage surge is not applied and, therefore, that the LHMT lamp does not light for these classes. The LHMT lamp should light for all other classes. The LLJ and TLH lamps should light for all classes.

C5-3.16 TEST OF FALSE CROSS AND GROUND DETECTION FEATURE (SFD-C535)

C5-3.16.1 FCG Key Normal

With the FCG key normal, the FCG relay of the CM is connected to the network T and R leads prior to operation of the GLH and GLH1 relays. As on service calls, crosses or grounds on the T and R leads will be detected on light traffic calls.

C5-3.16.2 FCG Key Operated

With the FCG key operated, the FA resistor is bridged across the TTT and TRT leads to the marker. This applies a current which should operate the FCG relay causing a trouble card to be produced showing a FCG punch. If the HTR key is operated, the CM should not detect the FCG condition.

C5-3.17 TEST OF CONTINUITY TEST FEATURES (SFD-C535)

C5-3.17.1 CON, RV, AND TCT Keys Normal, TC Key Operated or Normal

With the CON, RV, TCT, and TC keys normal, an operate condition originating at the voltage divider resistors CL, CM and CK, through the CF resistor is applied to the TRT lead. On alternate test calls the RCTA relay of the CM is operated so that the initial continuity test is made on the RING lead (the TRT lead on a test call). The CON tube should fire and the call should be completed. On calls with the RCTA relay of the CM normal, the initial continuity test is made on the TIP lead (the TTT lead on a test call). Since the TTT lead is open, the CON tube does

not fire initially, but (as described for a service call) it should fire after release of the RCTA relay applies the continuity test to the TRT lead. Two consecutive calls should be made to ensure one test with RCTA initially normal and one test with RCTA initially operated. With the TC key normal, a negative bias is applied to the operate path of the CON tube. A test should also be made with the TC key operated to apply a positive bias to the CON tube operate path.

C5-3.17.2 RV Key Operated, CON and TCT Keys Normal, TC Key Operated or Normal

Operation of the RV key with the CON, TCT, and TC keys normal applies the aforementioned continuity operate test condition to the TTT lead instead of the TRT lead. Two consecutive tests should be made to ensure one test with RCTA initially operated and one test with RCTA initially normal. As described previously, The TC key may be operated or normal to apply positive or negative bias to the CON tube operate path.

C5-3.17.3 CON Key Operated, RV, TCT, and TC Keys Normal

With the CON key operated, a loop continuity operate condition is applied across the TRT and TTT leads. The CON tube should fire for OK continuity on its initial attempt whether the RCTA relay is operated or normal.

SECTION C, PART 6
COMPLETING MARKER RELEASE AND OUTGOING
SENDER OPERATION

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C6 COMPLETING MARKER RELEASE AND OUTGOING SENDER OPERATION

Upon successful completion of the double connection test and the ground test, the completing marker transmits an advance signal to the outgoing sender as an indication that the outgoing sender should assume supervision and complete the call. After the advance signal is sent to the sender, the marker checks that the functions in the sender are complete and that the linkage between the sender and the trunk are properly set up. If these tests are successful the marker releases. The outgoing sender, having prepared the distant register or sender to accept pulses, awaits a signal from the distant end to start outputting. After all the digits are outputted, supervision of the call is turned over to the trunk and the sender is released.

C6-1 COMPLETING MARKER RELEASE

The marker may encounter numerous conditions that require disconnect, and when these conditions occur the marker has various methods of disconnection.

C6-1.1 MARKER NORMAL RELEASE - OPERATION OF THE DIS1,2 RELAYS (SFD-C605)

When the marker has completed all functions successfully without encountering any trouble, the LK1 (linkage check) relay will operate causing the DIS1,2 (disconnect) relays in the CM to operate.

The DIS1,2 relays, operating, release the CKG1,2 relays in the CM and grounds the MRL lead into the OR (originating register) to operate the MRL relay (SFD-C107). The MRL relay, operating, releases the MS- relay in the ORMC, and by opening the start lead into the connector prevents a second trial (SFD-C104).

C6-1.1.1 Trouble Record - Operation of the TRR Relay (SFD-C605)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the TRR (trouble record regular) release relay. These conditions are as follows:

When the marker receives a permanent signal indication from the OR, the PS relay in the CM operates. If the APS (all permanent signal) key is operated at the JLK bay, the PSR relay in the CM operates. The PSR and PS relays operate the TRR relay in the CM and a trouble record is taken. The permanent signal trouble record is used to obtain the line information.

When the start lead is shifted to an alternate marker in the ORMC due to a delay in the selection of a marker, the TRS (transfer start) relay in the PC circuit operates. After the alternate marker is selected, the

TRS relay in the CM operates. The TRS relay operates the TRR relay in the CM and a trouble record is taken. The TRS trouble record is used to identify the connector used on the call.

A time out or cross failure will cause the CM to take a trouble record. If the marker usage is a first trial (TR2C relay normal) and the dialing connection has released (CB5, CHA, and TK relays operated), the TRR relay in the CM operates and a trouble record is taken. A second trial is not possible on this type of call because the OR has already released.

When the trouble record is completed, the DIS1,2 relays in the CM operate from the operated TRR, TRB1, RDL, and TRSA relays. The marker then releases on a normal basis.

C6-1.2 MARKER TROUBLE RELEASE - OPERATION OF THE TRL RELAY (SFD-C605)

If the CM encounters trouble while trying to complete the call, the TRL (trouble release) relay in the marker will operate. The TRL relay operating releases the CKG1,2 relays in the CM and grounds the TRL lead into the PC (preference control circuit) operating the TRL relay (SFD-C107). The TRL relay operating releases the MS- (marker start) relay in the ORMC. The Z relay in the PC changing condition shifts the ST (start lead) to the alternate marker and a second attempt is made to complete the call (SFD-C104). A trouble release permits a second trial providing the MRL or BT relays in the OR (originating register) are normal.

C6-1.2.1 Line Link Frame Make Busy (SFD-C605)

When a plug is inserted into the LMB jack at the LLF, the MB relay operates in the PC circuit. The MJ relay in the JLK circuit then operates and a major alarm is sounded.

As a result of the MB relay operating, the LLB relay in the marker (SFD-C405) operates and removes battery from the start lead. The LLB relay operates the RBT relay which operates the RDL and then the TRL which releases the marker on a trouble basis.

C6-1.2.2 Trouble Record - Operation of the TR1 Relay (SFD-C605)

There are conditions whereby the CM detects trouble and, before releasing, takes a trouble record by operating the trouble record trouble release TR1 relay. These conditions are as follows.

A time out or cross failure will cause the CM to take a trouble record. If the marker usage is a first trial (TR2C relay normal) and the dialing connection has not released (CB5, CHA, or TK relays normal), the TR1 relay in the CM operates and a trouble record is taken. A second trial is possible on this type of call because the OR is still attached to the

circuit. If the marker usage is a second trial, TR2C relay operated, the TR1 relay in the CM operates and a trouble record is taken. Since the marker usage is a second trial, the BT relay in the OR will operate opening the start lead preventing another attempt to complete the call.

When the trouble record is completed, the TRL relay in the CM operates from the operated TR1, TRB1, RDL, and TRSA relays. The marker then releases on a trouble basis.

C6-1.3 MARKER OVERALL TIME-OUT RELEASE - OPERATION OF THE MRL, MRL1 RELAYS (SFD-C137)

If the marker fails to complete the call within the allotted interval of 9.6 to 15.4 seconds, the OAT timer functions and causes the MRL (marker release) relay to operate. The MRL relay operates the MRL1 relay (SFD-C605) which operates the busy test BT and MRL relays in the OR (SFD-C107). The MRL relay operating releases the MS- relay in the ORMC and by opening the start lead into the connector prevents a second trial (SFD-C104).

On this type of release, a trouble record is not taken but the TA (timing alarm) lamp will be lighted on the equipment frame.

C6-1.4 CONTROL OF MARKER RELEASE BY THE MASTER TEST CONTROL CIRCUIT (SFD-C604 AND 605)

On test calls certain MT- (marker test) relays operate in the CM. These test relays operating allow the MTC circuit to interact with the marker.

With the MT17 relay operated in the CM, the DCT1 relay operating path is extended into the MTC circuit over the TDCT lead. The DCT1 relay operating ground is extended over the DCT lead into the MTC circuit to operate the DCT relay. With the REC key normal, the operation of the DCT relay in the MTC circuit operates the MO1 relay. The MO1 relay in the MTC circuit operating connects ground to the TDCT lead into the CM operating the DCT1 relay. The CM then continues its progress on a normal basis.

With the MT1 relay operated in the CM, the DIS1,2 relays operating path is extended into the MTC circuit over the DIS lead. After the LK1 (linkage check) relay in the CM operates, ground is extended over the LK2 lead into the MTC circuit. The LK2 relay in the MTC operates, lighting the LK2 lamp. Ground is now transmitted over the LK3 lead through the CM and back into the MTC on the DIS1 lead. The DIS1,2 relays in the MTC circuit operate, lighting the DIS1 lamp, and ground is extended over the DIS lead into the CM operating the DIS1,2 relays. The CM then gives a normal release. It may be noted that if the LK2 and DIS1 lamp at the MTC panel are both lighted, the marker has completed setting up the connection and released.

C6-1.4.1 Requesting Trouble Record Using MTC Circuit - Operation of the REC Relay (SFD-C605)

When it is desired to obtain a record of the progress of the CM when making a test call, the REC key (record request) should be operated at the MTC panel. The REC key operates the REC relay in the MTC after the DCT relay has operated. Thus, the REC relay is operated prior to the completing marker DCT1 relay. The REC relay operated extends ground into the CM over the TRR lead to operate the TRR relay. The TRR relay operates the TRST (trouble recorder start) relay in the CM which operates the MPR- marker preference relay in the MTFC to request a trouble record. A trouble record is taken and the CM releases on a normal basis. These trouble records requested by the test equipment can be distinguished from service or legitimate trouble records by the absence of the TI (trouble indication) punch on the trouble record card.

C6-1.5 TROUBLE RECORDER REQUESTS (SFD-C607)

When the marker encounters a trouble condition, the TRR or TR1 relay will operate in the CM and cause the trouble recorder to be seized by the trouble recorder start relay operating (SFD-C605). The TRST operates the TRSA relay in the marker. On first trial calls, the MN relay in the JLK circuit operates and a minor alarm is sounded. On second trial calls, the MJ relay in the JLK circuit operates and a major alarm is sounded. The marker preference MPR- relay in the MTFC circuit is then operated (SFD-C607) from battery on the TRST lead. The MPR- relay connects ground to the CI lead which operates the MKA, MKB, and MKB1 relays in the MTFC. The MKA relay operates the MTR (marker test repeat) relay which operates the CIC (cut-in connector) relay in the MTFC (SFD-C607) and a trouble record is taken.

After the trouble record is complete, ground over the TRC lead from the TRC (trouble recorder control) circuit operates the TRC and TRC1 (trouble record complete) relays in the MTFC. The RM (release marker) relay in the MTFC operates and ground is transmitted over the TRB lead into the CM to operate the TRB1,2 (trouble recorder busy) relays. The TRB1 relay operating removes battery from the TRST lead releasing the MPR- and MKA relays in the MTFC. The TRB2 relay operates the RDL (release delay) relay in the marker. The marker will then release on a normal or trouble basis.

C6-1.5.1 Trouble Recorder Busy - (SFD-C607)

When a trouble record is requested by the marker with the operation of the TRR or TR1 relays and there is a previous trouble record in progress with the TRB1 relay operated, the DL (display lost) relay in the marker will operate. The DL relay operating will cause the DL- (display lost) lamp in the JLK circuit to light, indicating the loss of a trouble record. The marker will then release on a normal or trouble basis.

C6-2 MF SENDER OPERATION

After the sender is connected to the completing marker, it registers the digits dialed and transmits them over the tip and ring conductors to the distant register or sender. When all digits are transmitted, supervision of the call is turned over to the trunk and the sender releases.

C6-2.1 MF SENDER - DIGIT REGISTRATION (SFD-C610)

The MF sender is designed to handle up to eleven digits, as recorded in the originating register. The digits are registered on dry reed relays, A through L, each relay having five independent coils with two make contacts. The marker operates these independent coils of the digit registration relays on a 2-out-of-5 basis from ground through the OSC circuit.

Since the number of digits an outgoing sender receives on different calls may vary, an indication is needed to mark the end-of-digit registration. This is the end-seven registration and consists of operating only the seven coil of the digit register one beyond the last registered digit.

The completing marker is able to detect missing digits since the registration must consist of 2-out-of-5 in each position up to the end-seven which is followed by a none-out-of-five. Should any of the digit registration relay coils in the sender fail to lock operated, the ORK1,2 (outgoing registration check) relays in the completing marker will not operate and the punch indication A'(2/5) - L'(2/5) will be missing from the trouble record card.

C6-2.2 MF SENDER-ARBITRARY DIGIT REGISTRATION - AR, BR, AND CR DIGIT REGISTERS (SFD-C610)

Provision is made in the sender for registering up to three arbitrary digits. These arbitrary digits originate in the marker and are used for code conversion and code prefixing. Any digits registered on the arbitrary digit registers will be transmitted ahead of digits registered on the A through L digit registers. These digits are registered on the AR, BR, and CR digit register relays.

C6-2.3 MF SENDER - STEERING CIRCUIT (SFD-C611)

The MF sender digit steering circuit consists of a KP (key pulse) relay, one steering relay per digit, AS to LS, a SP (start pulse) relay, and an EP (end-of-pulsing) relay.

When both the AV (advance) and ATM (auxiliary timer) relays have operated, the KP relay in the OS (outgoing sender) will operate. After the OS receives on-hook supervision, indicated by the OF (off-hook) relay in the OS releasing, the SP relay will operate (SFD-C615) to cause the steering relay for the first digit to be transmitted to operate.

The steering relay for the first digit operates through its own normal contacts and locks through the normal contacts of the remaining non-operated steering relays. This steering relay associates the RR 2/5 (recapture) relays with the digit register for the first digit to be transmitted (SFD-C612). A second make-contact of the steering relay operated transfers the locking circuit for the KP relay from the direct ON1 ground to the operating ground for the digit steering relay (SFD-C611). When this locking circuit is opened, as it will be when the PGI relay operates to terminate the key-pulse signal, KP releases. When the PGI relay releases, the ON1 ground is closed through the operated steering relay contacts for the first digit to cause the operation of the steering relay for the second digit. The circuit progresses in a similar manner for each digit to be transmitted with the PGI releasing to cause the operation of the steering relay for the next digit to be transmitted and operating to cause the release of the steering relay for the digit just transmitted.

C6-2.4 MF SENDER - RECAPTURE PRINCIPLE (SFD-C612)

The use of reed-type register relays AR to L with a limited number of contacts, necessitates the use of a set of translating or recapture relays for obtaining additional contacts for use at the time the digit is to be transmitted. The recapture relays consist of five general purpose relays RR-(2/5) (SFD-C612), which are associated with the digit registers successively by the steering circuit. In an MF sender, the recapture relays are used for connecting the proper combination of frequencies to the tip and ring for transmission of the registered digits to the distant office. The recapture relays are also used to operate the end-of-pulsing relay after the last digit is transmitted.

C6-2.5 MF SENDER - LAST DIGIT INDICATION (SFD-C610)

The steering relays control the LD (last digit) relay, which is used to indicate the number of digits registered in the sender. Relay LD is operated initially on its primary winding when the ON relay in the sender operates. After the first digit steering relay operates, the locking ground for the digit register relay, two digits beyond, is transferred to the LD relay secondary winding locking circuit. This provides a holding circuit for the LD relay when the primary winding operating path is opened, and enables the sender to determine two digits ahead when a no-digit or end-seven signal is registered on the digit register relay.

After the key-pulse signal is transmitted, the primary winding of the LD is opened by the release of the KP relay. With the steering relay for the first digit operated, the second digit steering relay will operate to provide a new holding circuit for the LD relay when the steering relay for the first digit is released. The LD relay will release after the release of the steering relay for the next to last digit registered in the sender.

C6-2.6 MF SENDER - TRUNK GUARD TEST

A trunk test is made by the sender to test for battery and ground on the tip and ring conductors. If the sender finds an open trunk toward the distant office, the marker will time-out, take a trouble record, and set the sender to return a reorder signal to the trunk. If the sender recognizes correct supervision and the TG test is performed satisfactorily, the marker will then release on a normal basis. (See SCD-C2 for a more detailed description.)

C6-2.7 MF SENDER - TRUNK TEST TIMING (SFD-C613)

The trunk cover-up interval is timed by the ATM timer. On a regular class call, this interval is timed before the tip and ring loop is closed to insure that the trunk is fully released from a previous connection. After the ON relay in the sender operates connecting the ATM3 resistor to the timing circuit, it will take 460 to 900 ms for the ATM capacitor to become sufficiently charged to operate the auxiliary timer ATM relay. At this time the AV relay in the sender will usually be operated, and when it is operated, the KP relay in the sender will operate and open the circuit for the ATM relay.

The ATM relay releases and, with the KP relay operated, operates the ATC relay in the sender (SFD-C615) to restart the timer for timing the intersender interval.

C6-2.8 MF INTERSENDER TIMING (SFD-C613)

Intersender timing is performed by the ATM timer. After the ATC (auxiliary timer control) relay in the sender operates, the ATM capacitor charging path is through the ATM5 resistor. With the ON and ATC relays operated in the sender, it will take from 4.4 to 8.4 seconds for the ATM capacitor to become sufficiently charged to operate the ATM tube and relay.

Under normal operating conditions, a distant register or sender will be attached to the OS without delay and the SP (start pulsing) relay in the sender will operate to open the circuit to the ATM relay before it is able to operate. However, if the connection of a register or sender is delayed beyond 8.4 seconds, the ATM relay will operate and, with the ATC operated, close a path from the winding of the RO (reorder) relay (SFD-C615) over the WA lead to the outgoing sender group release circuit. The marker finding an all-sender or register busy condition in the distant office will operate the release relay of the sender group release circuit which in turn will ground the WA lead. When the WA lead is grounded, with the SP relay normal, the RO relay will operate to release the sender. Relay RO operates the OF (overflow) relay (SFD-C213) of the OGT and releases the CT relay causing the sender to release.

C6-2.9 MF SENDER - REGULAR CLASS - OPERATION OF THE TG AND OF RELAYS (SFD-C616)

Regular class includes all one-way trunks except intertoll and any trunk in which the CL2 (class) relay remains normal. The sender requires a change in supervision from off-hook to on-hook as a start pulsing signal. These trunks, in general, are on-hook when normal, change to off-hook when the line is connected to a distant register or sender and then revert to on-hook when the distant end is ready to accept pulses.

When the marker has completed its job of establishing the connection, the sender AV relay has operated, the sender has timed the cover-up interval, and the sender KP relay has operated, the tip and ring leads are closed to the windings of the TG and OF relays in the OS. With the CO (cut-off) relay in the incoming trunk normal, the supervision is on-hook and the battery and ground from the A relay in the trunk will operate the outgoing sender TG (trunk guard) relay and the OF (off-hook) relay will bias or remain normal. The TG1 relay in the OS then operates and opens the TG lead to the marker. When the CO relay in the incoming trunk operates the supervision is changed to off-hook and the A relay battery and ground is removed from the tip and ring leads. The tip and ring leads are now connected to the IR (incoming register) where the battery and ground from the line supervisory A relay is in a direction to operate the OF relay in the OS. The TG and OF1 relays in the outgoing sender will also operate at this time.

C6-2.10 MF SENDER - START PULSING SIGNAL (SFD-C617)

The outgoing sender must receive a change in supervision from off-hook to on-hook before it can start outpulsing.

The operation of the RV (reversal) relay in the distant incoming register reverses the polarity of the tip and ring leads to the OS. When the reversal is recognized by the outgoing sender, the OF relay will release changing the supervision to on-hook. The TG relay in the OS will also release, but only momentarily, and then reoperate to cause the SP (start pulsing relay) to operate through the still operated, slow release OF1 relay contacts, and the normal OF relay contacts (SFD-C615).

C6-2.11 MF SENDER - PULSE GENERATOR (SFD-C613)

The pulse generator consists of the PG and PG1 relays and their associated capacitors and resistors. The mercury-type polarized PG relay is nonbiasing and can be operated in both directions to its front or back contacts.

When the ON relay in the sender operates, the PG relay will operate from current flowing through its primary winding. The PG relay will remain operated until the PG capacitor becomes charged and then release through its secondary winding. The PG relay will remain normal until the SP relay in the OS operates.

When the SP relay operates, the PG relay will operate from current flowing through its secondary winding. The PG and SP operated will cause the PGI relay in the OS to operate. The PGI relay operating reverses the circuits through both windings of the PG again, causing the PG relay to release. This cycle is repeated as long as the PG relay maintains control of the PGI relay. When it is desired to stop the pulse generator an alternate circuit to the PGI relay is closed, thus, preventing release of the PGI relay and stopping the interrupter.

C6-2.12 MF SENDER - GENERATION OF FREQUENCIES (SD-26051-FS12)

Where it is economical, a frequency generator will be provided per sender. The six multifrequency signals are generated in the sender by transistor oscillators. The power for starting the oscillators is applied when the sender is seized and the ON relay operates (SFD-C616).

C6-2.13 MF SENDER - ASSIGNMENT OF FREQUENCIES

The six frequencies generated in the MF outgoing sender are assigned in steps of 200, from 700 to 1700 cycles. The first five frequencies are assigned on a 2-out-of-5 basis to the digits 0 to 9 and the sixth is used in combination with others of the first five as the key pulse and start pulse signal. The frequencies are assigned designations 0, 1, 2, 4, 7 and 10 so as to fit in with the standard additive 2-out-of-5 code. The frequencies and their assignments are as follows:

FREQUENCY					
700	900	1100	1300	1500	1700
DIGIT DESIGNATION					
0	1	2	4	7	10
0			x	x	
1	x				
2		x			
3	x	x			
4	x		x		
5			x		
6	x	x	x		
7				x	
8	x			x	
9		x		x	
Key Pulse		x			x
ST Pulse				x	x

C6-2.14 MF SENDER - TRANSMISSION OF FREQUENCIES (SFD-C616 AND C617)

The outgoing sender frequencies are connected to the input side of the repeating coil by the KP and RR-(2/5) relay contacts. When the KP and SP relays in the OS are operated, the key pulse signal (frequencies 2 and 10) is transmitted over the tip and ring leads into the MF receiver at the distant end (SFD-C617). The key pulse signal acts as a gate opener, activating the MF receiver to enable it to start accepting subsequent pulses from the OS. After a timed interval, the PG1 relay in the sender operates, disconnecting the key pulse signal from the tip and ring leads to release the KP relay. When the PG1 relay releases, the frequencies for the first digit (stored on the RR2/5 relays) are transmitted over the tip and ring leads into the MF receiver. After a timed interval, the PG1 relay will again operate, disconnecting the frequencies associated with the first digit from the tip and ring leads. The PG1 relay operating, releases the steering relay for the first digit, thus, placing the RR2/5 relays under control of the next digit steering relay (SFD-C612). As the PG1 relay releases and reoperates, the process just described will continue until all digits have been transmitted.

After all registered digits have been transmitted, the RR2/5 relays will be associated with a digit register relay which has only the -7 relay operated. This will cause the start pulse signal, frequencies 7 and 10, to be transmitted over the tip and ring leads to notify the MF receiver at the distant end that all of the digits have been transmitted. The PG1 relay will then operate to terminate the start pulse signal and release the steering relay. With all of the RR- relays normal the EP (end pulsing) relay will operate to start the release of the sender.

C6-2.15 MF SENDER - TWO-OUT-OF-FIVE CHECK (SFD-C613)

A feature is provided in the pulse generator circuit to check that only two of the five recapture RR-(2/5) relays are operated for each digit transmitted. As the recapture relays are transferred from one digit to the next, the PG1 relay will not release to advance to send the next digit unless the 2/5 check is satisfied. If the PG1 relay fails to release, the timing circuit will function and cause the sender to release.

C6-2.16 MTC AND AMRST CONTROL OF SENDER OUTPULSING (SFD-C614)

On test calls the MTC (master test control circuit) is used to prime the completing marker and establish the connection between the AMRST (automatic monitor register and sender test) circuit and the OS. The AMRST, after being connected to the outgoing sender by the operation of the M relay in the sender, monitors the operations in the sender by receiving data over a number of leads.

C6-2.16.1 Sender Reorder Test - Operation of the ROT Relay (SFD-C614)

To simulate a reorder condition in the OS using the MTC circuit, the ROT (reorder test) key should be operated at the MTC panel. The ROT key operates the ROT relay in the MTC circuit. With the KOR (connect originating class) relay operated, ground is transmitted over the ROT lead through the MTFC, CM, and OSC into the sender and operates the RO relay. When the sender returns the locking ground over the RO lead the CK2 relay in the MTC circuit operates. The CK1 relay will then operate lighting the CK1 lamp.

C6-2.16.2 Start Pulse Signal to AMRST (SFD-C614)

When the sender is ready to start outputting and the AMRST circuit is attached to the sender by the M relay, operating ground is transmitted over the PL lead to operate the DSM (dial pulse) or PL (pulsing) relay in the AMRST depending upon the type of sender used. The pulses are then received and checked by the AMRST.

C6-2.16.3 End Pulsing Signal to AMRST (SFD-C614)

After outputting has been concluded and the sender EP (end pulsing) relay has operated, ground is connected to the SPE lead into the AMRST circuit operating the pulse end SPE or SPE1 relay, depending upon the type sender used.

C6-2.16.4 Trouble Block Test - Operation of the TB1 Relay (SFD-C614)

On a test call, as the result of a test failure, the TB1 (trouble block test) relay in the AMRST circuit operates. This causes the TBL (trouble) relay in the AMRST circuit to operate, lighting the TBL lamp.

C6-2.16.5 Test Completion and Release of AMRST

On a test call when the sender starts to release the TAC2 (test abandoned call) relay operates in the AMRST circuit. The OK relay will then operate, lighting the OK lamp and will release the sender (followed by the AMRST circuit). However, the AMRST circuit will not release completely until the STT key is restored to normal.

C6-2.17 RELEASE OF THE MF SENDER (SFD-C615)

The MF sender is designed to output the registered digits and then turn the supervision over to the trunk and release. After the last digit has been transmitted, all of the RR2/5 relays will remain normal and cause the EP (end pulsing) relay to operate. The EP relay operating, releases the outgoing trunk D relay and the sender CT (cut-through) relay. The LR (line release) relay will then release causing the ON and ON1 relays in the sender to release. After the ON1 relay releases, the SB (sender busy) relay releases reclosing the busy test leads, restoring the sender to normal.

C6-2.18 MF SENDER - TM TIMER (SFD-C613)

The sender TM timer measures the interval between the seizure and release of the sender. If the sender operation is not completed within the allowable interval of 12.7 to 24 seconds, the TM timer functions and operates the TM relay in the OS.

The TM relay operates the TRL relay in the sender (SFD-C615), which grounds the stuck sender register lead SS into the plant register circuit, grounds the LP lead into the JLK circuit, lighting the TO lamp, grounds the ALM lead into the JLK circuit to start the office timer, and operates the RO (reorder relay) in the sender (SFD-C615). The RO relay operating connects a resistance battery to the AB lead through the OSL to operate the marginal overflow OF relay in the OGT, transfers the LR relay from the AB lead to an ON ground, and releases the slow release CT relay (SFD-C213). Relay CT in releasing disconnects the resistance battery from the AB lead, disconnects ground from the stuck sender plant register lead, and releases the LR relay in the sender.

If the CTR (cancel timed release) key on the JLK bay is normal (pushed in) the release of the LR relay will cause the release of the ON relay followed by other operated relays in the sender. The TRL relay will release from the ON1 and remove grounds from the LP and ALM leads into the JLK circuit (SFD-C615). If the CTR key is operated (pulled out) the ON relay will be held operated through the TRL contacts (SFD-C213) and will maintain the grounds on the LP and ALM leads into the JLK circuit. The ground on the LP lead will light the TO lamp (SFD-C615) while the ground on the ALM will cause the major alarm to operate with the register sender time-out alarm indication. If the sender MB relay is operated by the insertion of a plug in the MB jack at the JLK bay, the ground is removed from the ALM lead which retires the major alarm and leaves the TO lamp lighted. When the CTR key is restored to normal (pushed in), the ON relay will release, allowing the release of the operated relays in the sender. When the ON1 relay releases, the TRL relay releases and extinguishes the TO lamp.

C6-3 DP SENDER OPERATION

After the sender is connected to the completing marker, it registers the digits dialed and transmits them over the tip and ring conductors to the distant register or sender. When all the digits are transmitted, supervision of the call is turned over to the trunk and the sender releases.

C6-3.1 DP SENDER - DIGIT REGISTRATION (SFD-C620)

The DP sender is designed to handle up to eleven digits, as recorded in the originating register. The digits are registered on dry reed relays, A through L, each relay having five independent coils with two make contacts. The marker operates these independent coils of the digit registration relays on a 2-out-of-5 basis from battery through the OSC circuit.

Since the number of digits an outgoing sender receives on different calls may vary, an indication is needed to mark the end-of-digit registration. This is the end-seven registration and consists of operating only the seven coil of the digit register one beyond the last registered digit.

The completing marker is able to detect missing digits since the registration must consist of 2-out-of-5 in each position up to the end-seven which is followed by a none-out-of-five.

Should any of the digit registration relay coils in the sender fail to lock operated, the ORK1,2 (outgoing registration check) relays in the completing marker would not operate and the punch indication A'(2/5) - L'(2/5) would be missing from the trouble record card.

C6-3.2 DP SENDER - ARBITRARY DIGIT REGISTRATION - AR, BR, AND CR DIGIT REGISTERS (SFD-C620)

Provision is made in the sender for registering up to three arbitrary digits. These arbitrary digits originate in the marker and are used for code conversion and code prefixing. Any digits registered on the arbitrary digit registers will be transmitted ahead of digits registered on the A through L digit registers. These digits are registered on the AR, BR, and CR digit register relays.

C6-3.3 DP SENDER - STEERING CIRCUIT (SFD-C621)

The DP sender digit steering circuit consists of one steering relay per digit, AS to LS.

When both the AV (advance) and ON1 (off-normal) relays have operated in the OS (outgoing sender), the steering relay for the first digit to be transmitted will operate.

The steering relay for the first digit operates through its own normal contacts and locks through the normal contacts of the remaining non-operated steering relays. This steering relay associates the RR(2/5) (recapture) relays with the digit register for the first digit to be transmitted (SFD-C622). After the OS receives on-hook supervision, indicated by the off-hook OF relay in the OS releasing, the TT1 (trunk test completed) relay in the OS will operate (SFD-C624) to cause the operation of the steering relay for the second digit.

When transmission of the first digit is completed, the Z relay in the OS will operate and cause the steering relay for the first digit to release (SFD-C621). The second digit steering relay is now controlling the operation of the RR(2/5) relays. The circuit progresses in a similar manner for each digit to be transmitted with the Z relay releasing to cause the operation of the steering relay for the next digit to be transmitted and operating to cause the release of the steering relay for the digit just transmitted.

C6-3.4 DP SENDER - RECAPTURE PRINCIPLE (SFD-C622)

The use of reed-type register relays AR to L with a limited number of contacts, necessitates the use of a set of translating or recapture relays for obtaining additional contacts for use at the time the digit is to be transmitted. The recapture relays consist of five general purpose relays RR(2/5) (SFD-C622), which are associated with the digit registers successively by the steering circuit. In a DP sender, the recapture relays are used to change the two-out-of-five registration to a one-out-of-ten translation for control of the dial pulse generator (SFD-C625). The recapture relays are also used to operate the end-of-pulsing relay after the last digit is transmitted.

C6-3.5 DP SENDER - CANCEL OFF-HOOK INDICATION (SFD-C620)

The steering relays control the COF (cancel off-hook) relay, which is used to indicate the number of digits registered in the sender. Relay COF is operated initially on its primary winding when the ON1 relay in the sender operates. After the first digit steering relay operates, the locking ground for the digit register relay, two digits beyond, is transferred to the COF relay secondary winding locking circuit. This provides a holding circuit for the COF relay when the primary winding operating path is opened, and enables the sender to determine two digits ahead when a no-digit or end-seven signal is registered on the register relay.

Before the first digit is transmitted, the primary winding of the COF is opened by the operation of the TT1 relay. With the steering relay for the first digit operated, the second digit steering relay will operate to provide a new holding circuit for the COF relay when the steering relay for the first digit is released. The COF relay will release after release of the steering relay for the next-to-last digit registered in the sender.

C6-3.6 DP SENDER - TRUNK GUARD TEST

A trunk test is made by the sender to test for battery and ground on the tip and ring conductors. If the sender finds an open trunk toward the distant office, the marker will time-out, take a trouble record, and set the sender to return a reorder signal to the trunk. If the sender recognizes correct supervision and the TG test is performed satisfactorily, the marker will then release on a normal basis. (See SCD-C2 for a more detailed description.)

C6-3.7 DP SENDER - TRUNK TEST TIMING (SFD-C623)

The trunk cover-up interval is timed by the ATM timer. On a regular class call, this interval is timed before the tip and ring loop is closed to insure that the trunk is fully released from a previous connection. After the ATC (auxiliary timer control) relay in the sender operates connecting the ATM3 resistor to the timing circuit, it will take 0.62-to-1.2 seconds for the ATM capacitor to become sufficiently charged to operate the ATM (auxiliary timer) relay. At this time the AV relay in the sender will usually be operated, and when it is operated, the ATC relay in the sender will release and open the circuit for the ATM relay.

The ATM relay releases and, with the TTK relay operated, operates the ATC1 relay in the sender (SFD-C624) to restart the timer for timing the intersender interval.

C6-3.8 DP INTERSENDER TIMING (SFD-C623, C624)

Intersender timing is performed by the ATM timer. After the ATC1 (auxiliary timer control) relay operates, the ATC relay in the sender will reoperate. With the TTK, ATC1, and ATC relays in the sender operated, the ATM5 resistor becomes effective in the ATM capacitor charging circuit. It will take from 4.4 to 8.4 seconds for the ATM capacitor to become sufficiently charged to operate the ATM tube and relay.

Under normal operating conditions, a distant register or sender will be attached to the OS without delay and the TT1 (trunk test completed) relay in the sender will operate to release the ATC relay and open the circuit to the ATM relay before the ATM relay is able to operate. However, if the connection of a register or sender is delayed beyond 8.4 seconds, the ATM relay will operate and, with the ATC1 operated, close a path from the winding of the RO relay (SFD-C624) over the WA lead to the outgoing sender group release circuit. The marker finding an all-sender or all-register busy condition in the distant office will operate the release relay of the sender group release circuit which in turn will ground the WA lead. When the WA lead is grounded the RO (reorder) relay will operate to release the sender. Relay RO operates the OF (overflow) relay (SFD-C213) of the outgoing trunk circuit and releases the CT relay allowing the sender to release.

C6-3.9 DP SENDER - REGULAR CLASS - OPERATION OF THE TG AND OF RELAYS (SFD-C626)

Regular class includes all one-way trunks except intertoll and any trunk in which the CL2 (class) relay remains normal. The sender requires a change in supervision from off-hook to on-hook as a start pulsing signal. These trunks, in general, are on-hook when normal, change to off-hook when the line is connected to a distant register or sender and then revert to on-hook when the distant end is ready to accept pulses.

When the marker has completed its job of establishing the connection, the sender AV (advance) relay will operate. The AV relay will operate the BD relay in the OS to remove the short from around the TG and OF relay windings. The BD relay operating will close the tip and ring leads to the windings of the TG and OF relays in the OS. With the CO (cut-off) relay in the incoming trunk normal, the supervision is on-hook and the battery and ground from the A relay in the incoming trunk will operate the outgoing sender TG (trunk guard) relay and the OF (off-hook) relay will bias or remain normal. The TG1 relay in the OS then operates and opens the TG lead to the marker. When the CO relay in the incoming trunk operates, the supervision is changed to off-hook and the A relay battery and ground is removed from the tip and ring leads. The tip and ring leads are now connected to the IRDP where the battery and ground from the line supervisory L relay is in a direction to operate the OF relay in the OS. The TG and TT relays in the outgoing sender will also operate at this time.

C6-3.10 DP SENDER - START PULSING SIGNAL (SFD-C624)

The outgoing sender must receive a change in supervision from off-hook to on-hook before it may start outputting.

The operation of the RV (reversal) relay in the distant incoming register reverses the polarity of the tip and ring leads to the OS. When the reversal is recognized by the outgoing sender, the OF relay will release changing the supervision to on-hook. The TG relay in the OS will also release but only momentarily and then reoperate to cause the trunk test completed TT1 relay to operate through the normal OF relay contacts (SFD-C624). The TT1 relay operates the digit steering relay for the second digit and also places the sender P relay under control of the BD, W, and SP relays (SFD-C623). The ATC1 relay will also release, followed by the TGT and BD relays, which allows the first digit to be dial pulsed.

C6-3.11 DP SENDER - PULSE GENERATOR (SFD-C623)

The pulse generator consists of the P and PG relays, and their associated capacitors and resistors. The mercury-type PG (polarized) relay is non-biasing and can be operated in both directions to its front or back contacts.

When the ON relay operates, the P relay in the OS will operate through the SP, W, and TT1 relays normal. The PG relay will then operate from current flowing through its primary winding. The PG relay will remain operated until the PG capacitor becomes charged and then release through its secondary winding. The PG relay will remain normal until the P relay in the OS releases.

When the P relay releases, the PG relay will operate from current flowing through its secondary winding. The PG relay operating causes the P

relay to reoperate, reversing the circuits through both windings of the PG again, causing the PG relay to release. This cycle is repeated as long as the PG relay maintains control of the P relay. When it is desired to stop the pulse generator, an alternate circuit to the P relay is closed, thus, preventing release of the P relay and stopping the interrupter.

C6-3.12 DP SENDER - PULSE COUNTING CIRCUIT - OPERATION OF THE P1
THROUGH P5 RELAYS (SFD-C623)

The DP sender counting circuit is used to count the number of dial pulses generated in the OS and then recycled to count the interdigital interval pulses.

The DP counting circuit consists of relays P1 through P5. The P1 and P2 relays are wired as a pulse divider and the P3, P4, and P5 relays are used in various combinations to count and remember the number of operations of P1 and P2. These relays are controlled by the sender P relay operating and releasing. When the ON relay operates, the P and LR relays in the OS operate. After the trunk test completed TT1 relay operates, the P relay releases and causes the P1 relay in the OS to operate. At the end of the first open pulse the P relay will reoperate to operate relay P2. On the next release of P, the P2 relay releases. This cycle is repeated with the P1 and P2 relays remaining operated at the end of each odd numbered pulse and normal at the end of each even numbered pulse.

The counting circuit has a feature which enables it to detect when a count of more than 10 pulses is reached. This condition will leave the P5 operated with the P3 and P4 relays normal. If this condition is reached, the TRL relay in the OS will operate, indicating a trouble condition exists (SFD-C625).

The following table gives a sequence of these operations.

<u>Pulse</u>	<u>P</u>	<u>P1</u>	<u>P2</u>	<u>P3</u>	<u>P4</u>	<u>P5</u>	<u>Counting Relays Remaining Operated</u>
1	RLS OPR	0	0				P1, P2
2	RLS OPR	R	R	0			P3
3	RLS OPR	0	0		0		P1, P2, P3, P4
4	RLS OPR	R	R				P3, P4
5	RLS OPR	0	0	R			P1, P2, P4
6	RLS OPR	R	R			0	P4, P5
7	RLS OPR	0	0				P1, P2, P4, P5
8	RLS OPR	R	R	0			P3, P4, P5
9	RLS OPR	0	0		R		P1, P2, P3, P5
10	RLS OPR	R	R				P3, P5
11	RLS OPR	0	0	R			P1, P2, P5
12	RLS OPR	R	R				P5

C6-3.13 DP SENDER - DIGIT CONTROL CIRCUIT (SFD-C625)

The digit control circuit consists of the BD (between digit) relay, the SP (stop pulsing) relay, and the function dividing relays W and Z.

When the AV (advance) relay has operated, the BD relay in the OS operates removing the short from the TG and OF relay windings (SFD-C626). After the trunk test has been completed the TT1 relay in the OS operates releasing the BD relay allowing the first digit to be dial pulsed.

The SP relay is used to terminate the dial pulses for each digit and for each interdigital interval. As the DP generator functions, the number of P relay operations is counted on the P1 to P5 relays. The SP winding is connected to the P1 to P5 relay contacts which are wired to the corresponding RR-(2/5) relays or through the Z relay contacts. When the P- relays have counted to the combination closed by the operated RR-(2/5) relays, the ON ground will operate the SP relay. One-half pulse cycle later, with the SP operated and P normal, the P1 through P5 counting relays are recycled and release. The SP relay operating also operates the W relay. The SP relay will release one pulse cycle later when the P relay operates. When the W relay is operated, the SP relay releasing will operate the Z relay. The Z relay operates the BD relay in the OS enabling the supervisory TG and OF relays. The Z relay also closes a circuit around the RR- relay contact to the P-, counting relay, contacts controlling the SP relay operation after a predetermined number of interdigital pulse cycles of the pulse generator. The number of interdigital pulse cycles is determined by the ID to ID- cross-connect (SFD-C625). The ID to ID5 cross-connect allows for an interdigital interval of 5 1/2 pulse cycles. At the end of the fourth interdigital pulse, with the P and Z relays operated, the SP relay operates and releases the W relay. At the end of the fifth interdigital pulse, the P relay operating releases the SP followed by the Z and BD relays. With both the W and SP relays normal, the next release of relay P opens the tip and ring conductors (SFD-C626). With the Z relay normal, the SP relay is again under the control of the RR-(2/5) relays. The release of the SP relay also releases the BD relay allowing the next digit to be dial pulsed.

This entire operation can be summarized as follows and is repeated for each digit. The BD relay releases and the digit is dial pulsed. The SP relay operates to terminate the digit and operates the W relay and recycles the counting relays. The SP relay releases, operating the Z relay which sets the counting relays to count to the interdigital interval and operates the BD relay. At the end of the fourth interdigital pulse, the SP relay operates releasing the W relay and recycling the counting relays. At the end of the fifth interdigital pulse, the SP relay releases followed by the Z which places the SP relay under the control of the P1 to P5 counting and RR-(2/5) relays. The SP releasing also releases the BD relay allowing the next digit to be dial pulsed.

C6-3.14 DP SENDER - TRANSMISSION OF DIAL PULSES (SFD-C626 AND C627)

After the OS receives on-hook supervision and the TT1 relay has operated, the BD relay in the OS will release causing the P relay in the pulse generator circuit to release (SFD-C623). The P relay in the OS releases the L relay in the distant IRDP. When the P relay reoperates, the L relay will also reoperate. With the BD and SP relays normal, the P relay in the OS (releasing and operating) opens and closes the tip and ring conductors which release and operates the L relay in the IRDP.

As long as the P relay maintains control of the tip and ring closure, the L relay in the IRDP will count the dial pulses transmitted by the OS.

When the SP relay in the OS operates, an auxiliary tip and ring closure is established around the P relay contacts and the L relay in the IR will remain operated. This indicates to the IR the end of the digit pulses and the start of the interdigital interval in the OS.

C6-3.15 RELEASE OF DP SENDER (SFD-C624)

The DP sender is designed to output the registered digits and then turn the supervision over to the trunk and release. After the last digit has been dial pulsed the SP relay in the OS operates releasing the P1 to P5 counting relays. One pulse cycle later, when the P relay operates, the SP relay will release operating the Z relay which releases the last digit steering relay. The last digit steering relay releasing will place the RR-(2/5) relays under control of the last operated steering relay and the digit registration relay having only the -7 operated. This will cause only the RR7 relay to operate. With the COF relay normal and the TT1 relay operated, the EP relay will operate through the normal RR0,1,2, and 4 relays. The EP relay operating will close an auxiliary circuit to relay P holding it operated and stopping the pulse generator. The EP relay operating also releases the outgoing trunk D relay and the sender CT relay. The LR relay will then release causing the ON and ON1 relays in the sender to release. After the ON1 relay releases, the SB relay releases reclosing the busy test leads restoring the sender to normal.

C6-3.16 DP SENDER TM TIMER (SFD-C623)

The sender TM timer measures the interval between the seizure and release of the sender. If the sender operation is not completed within the allowable interval of 19 to 37 seconds, the TM timer functions and operates the TM relay in the OS.

The TM relay operates the TRL relay in the sender (SFD-C624), which grounds the SS (stuck sender) register lead into the plant register circuit, grounds the LP lead into the JLK circuit lighting the TO lamp, grounds the ALM lead into the JLK circuit to start the office timer, and operates the RO (reorder relay) in the sender (SFD-C624). The RO relay operating connects a resistance battery to the AB lead through the OSL to operate the marginal OF (overflow) relay in the OGT, transfers the LR relay from the AB lead to an ON ground, and releases the slow release CT relay (SFD-C213). Relay CT in releasing disconnects the resistance battery from the AB lead, disconnects ground from the stuck sender plant register lead, and releases the LR relay in the sender.

If the CTR (cancelled timed release) key on the JLK bay is normal (pushed in) the release of the LR relay will cause the release of the ON relay followed by other operated relays in the sender. The TRL relay will release from the ON1 and remove the grounds from the LP and ALM leads into the JLK circuit (SFD-C624). If the CTR key is operated (pulled out) the ON relay will be held operated through the TRL contacts (SFD-C213) and will maintain the grounds on the LP and ALM leads into the JLK circuit. The ground on the LP lead will light the TO lamp (SFD-C624) while the ground on the ALM will cause the major alarm to operate with the register sender time-out alarm indication. If the sender MB relay is operated by the insertion of a plug in the MB jack at the JLK bay the ground is removed from the ALM lead retiring the major alarm leaving the TO lamp still lighted. When the CTR key is restored to normal (pushed in), the ON relay will release, allowing the release of the operated relays in the sender. When the ON1 relay releases the TRL relay releases and extinguishes the TO lamp.

SECTION C, PART 7

NO SENDER OPERATION

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C7 NO SENDER OPERATION

Sender operation and selection is controlled via the OS- punching associated with an operated route relay. Cross-connections permit the CM (completing marker) to select a sender of the desired type or indicate NSO (no sender operation). Typical trunks using NSO are operator trunks, service code trunks, revertive call trunks, and tone trunks.

C7-1 NSO RELAY OPERATION (SFD-C702, C704)

The destination or service requested by the calling customer will be indicated by the code digits passed to the CM from the OR (originating register). After receiving the customers dialed digits, the CM makes whatever translation is required for the purpose of grounding a code point. This grounded code point is the markers record of the customers request on this call.

This code point is cross-connected to operate a preroute or route relay (SFD-C706), which indicates the type of call.

The operation of the route relay will extend ground through the OS- to NSO cross-connection in the CM to operate the NSO relay (SFD-C704).

The sequence chart for operator trunks and service codes, shown on SFD-C702, is only a partial sequence chart showing the operation of the NSO relay. For complete overall operation SFD-C102, C116 and C302 must be used.

- (a) SFD-C102 - Sequence chart for seizure of completing marker by the originating register.
- (b) SFD-C116 - Sequence chart of translation, screening and routing.
- (c) SFD-C302 - Sequence chart, trunk link frame selection, and trunk selection.

C7-1.1 NSO - ZERO OPERATOR (SFD-C704, C706)

When the OR records the single digit 0 (A4 and A7 on 2/5), it engages a CM without waiting for any additional digits. The CM establishes a channel between the calling line and an outgoing trunk to an operator and releases. The customer hears an audible ringing signal until the operator answers.

The method for grounding code point Z0 is shown on SFD-C704. Route relay operation for 0 operator is shown on SFD-C706.

C7-1.2 NSO - MANUAL CALLS (SFD-C704, C706)

A dial office may also serve some customers who require the assistance of an operator on all originating calls.

When a customer with manual class of service lifts the receiver from the switch hook, the LLMC (line link marker connector) engages a DTM (dial tone marker). At the same time that it is receiving the LL frame location and the class of service of the calling line from the LLMC, the DTM selects an idle OR as though the call were from a dial station. The DTM transmits this information to the OR and releases. No dial tone is returned to the customer because the OR recognizes the class of service of the calling line as a manual class. The OR then seizes a CM and indicates that a connection to an operator is required. The CM establishes a channel between the calling customer and an outgoing trunk associated with a DSA operator. The operator then completes the call at the request of the customer.

The grounding of the ZO code point will be the same for a manual call as for a zero operator call shown on SFD-C704. The operation of the AC4 and AC7 relays for a manual call is shown on SFD-C704.

C7-1.3 NSO-X11 SERVICE CODE CALLS (SFD-C704, C706)

For service code calls, information, repair service, business office, etc, the OR receives the service code digits, engages a CM, and transmits the digits to the CM. The CM then sets up a channel between the calling customer and an outgoing trunk connected to the proper operator or desk and releases.

The illustration of grounding the code points and operating the route relays is shown on SFD-C704, C706, using the X11 translator. Only the A digit is passed from the OR to the CM for translation.

C7-1.4 NSO - REVERTIVE CALL TRUNK (SFD-C702, C703, C705, C706)

A reverting call is a call to a customer on the same line as the calling customer.

When a reverting call is required, a connection is established from the customers line through the LL and TL switches to:

- (a) a reverting trunk if charging is not required, or
- (b) an operator trunk if charging is required or reverting trunks are not furnished.

Customers instructions for making a reverting call vary, as described in the circuit descriptions for the reverting call trunks. However, all instructions require dialing the directory number of the called party, which in turn is transmitted to the marker through the ORMC.

Since all customers on the same line have the same line location, the CM makes the reverting test by matching the calling line location against the call line location, and if a match is made the call is handled as a reverting call.

The general sequence of operation is as follows (SFD-C703).

- (a) The calling line location is received from the OR and is stored in the CM. The called number is also received and translation of its office code causes the call to proceed as an ITR call with FLG linkage.
- (b) When translation from the number group is received and recorded, an operate circuit for the RV1,2 relays (SFD-C705) is closed in the calling and called line location match circuit. The RV relay operates from the operated RV1,2 relays indicating a reverting call.
- (c) The CM route advances, sequence chart SFD-C702, dropping the ITR trunk connection and selects a reverting trunk (RV) route (SFD-C706).
- (d) The call is now handled as an SOG call between the calling customer and the reverting trunk.
- (e) Since it is a reverting call, the ringing selection switch is operated. The ringing combination required was obtained from the number group translation and held in the CM by the operation of the RV relay. The number group line location relays release on route advance.
- (f) The CM passes the ringing information to the trunk and checks the ringing switch before releasing. The connection is left under supervisory control of the reverting trunk.

C7-1.5 NSO-ROUTE ADVANCE-TONE TRUNKS (SFD-C702, C705)

On any type of call, the CM may receive a signal or detect a condition indicating that the call cannot be completed in a normal manner and, therefore an alternative action is necessary. The alternative action taken by the marker depends on the type of call and the reason the call could not be completed.

Some of the more common reasons for alternative actions are:

- (a) TBTA, all trunks busy.
- (b) ASB, all senders busy.

- (c) FM, failure to match.
- (d) LBTA, called line busy.

Some of the more common alternative actions that may be taken by the marker are:

- (a) RAV1-2, route advance.
- (b) RYC, recycle.
- (c) RBT, originating register returns busy tone.

The CM provides six ground supplies. Depending on the office involved, the route relays are assigned to the ground supplies to provide the required direct and alternative routing.

Assignment of routes to ground supplies may be obtained from the office permanent record list, marker cross-connections, code point and route assignment.

When assigning the various routes to route relays, the following must be observed.

- (a) For route relays in ground supplies one-through-four, an advance can be made to any other ground supply.
- (b) A ground supply can be used only once on any call; that is, the marker cannot route advance to a ground supply, if the associated GS- relays are operated.
- (c) Routes in ground supply five, used for tone trunks, can be direct routes, but in general, are alternate routes for those in ground supplies one-through-four.
- (d) Routes in ground supply six, used for common overflow, are usually alternate routes for those in ground supply five.
- (e) Route advance out of ground supply six results in setting the originating register to return busy tone.

The relay operation for route advance is shown on SFD-C514 sequence chart. The operation of the RAV1,2 results in the operation of the RDL, RYC, GS-, and the release of off-normal control relays such as the LLC1-3, TLC1,2, CKG4, ONX and HMS1.

The above relay action results in:

- (a) Release of trunk and TL.
- (b) Release of LL.

- (c) Release of TL and LL select and hold magnet controls.
- (d) Releases all route relay information in the ground supply of the operated GS- relay except the route advance information.
- (e) Releases all linkage check and selection check relays.
- (f) Advances the junctor sequence relays.

When the marker has released to the point where functions associated with the new route can start, the SNK (SFD-C307) relay releases and permits the RAV1,2 (SFD-C517) relays to release.

The release of the RAV1,2 relays causes the following action:

- (a) Release the RYC and RDL (SFD-C517).
- (b) Permits the ONX (SFD-C108), TLC1,2 (SFD-C306), LLC1,2,3 and CKG4 (SFD-C307) control relays to reoperate.
- (c) Releases the RA- (SFD-C119) relay, which causes the new R- (SFD-C132) relay to operate.

SECTION C, PART 8

MAINTENANCE

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C8 MAINTENANCE

This part of the C section covers some of the aspects of the use of the master test control frame to detect, locate, and clear trouble on outgoing type calls.

C8-1 USE OF THE MASTER TEST CONTROL FRAME TO SIMULATE CALLS WHICH PRODUCE TROUBLE RECORDS

Analysis of trouble record cards using the trouble analysis chart and sequence charts of part C0 localize the trouble to an area which may involve a path through one or two relay contacts within one circuit, or may involve a path through many relay contacts in several circuits. Generally, it is impossible to troubleshoot the path on a static basis. The contacts which close to establish the path are often closed for only a fraction of a second during marker holding time. Frequently, the path which produced the failure is used only when a particular configuration of circuits or network paths is used. For this reason, it is desirable to be able to reproduce the same condition which caused the trouble in the beginning. The master test control circuit provides the means for such controlled simulation of actual calls without affecting service.

C8-2 USE OF SIMULATION TABLE AND ILLUSTRATED TROUBLE RECORD CARDS

The purpose of simulation tables in SFD-C802, C804, and C806, is to correlate trouble record card designations with the key(s) or switch(es) of the master test control frame, which should be operated to provide input or control to the CM when simulating a trouble record card. Included, for easier reference, is a trouble card designation location for different types of trouble cards. The three types of trouble record cards illustrated are E-5488 (2/X double sided) shown on SFD-C803, E-4393 (1/X double sided) shown on SFD-C805, and E-3638 (1/X single sided) shown on SFD-C807.

The drawing in SFD-C803, C805, and C807 depict a trouble record card which includes all of the possible designations (colored) which might be perforated on a record produced by an outgoing type call. A color key arrangement is used to indicate the different functions of designations regarding marker input or output information, progress of call, circuits or paths used, etc.

C8-2.1 FUNCTIONS OF ORIGINATING CLASS OF CALL (SOG)

One of the tables on SFD-C802, C804, or C806 and the associated colored trouble record card which corresponds to the type of trouble record card being analyzed should be used. The tables are divided into two parts. The left hand side of the chart shows functions used, designations perforated, and the designation location on a particular trouble record card. The right hand side of the chart lists the different key(s) or switch(es) used to simulate trouble record indications, depending on the type of master test control frame provided. The following is a brief description of the key and switch arrangements and their relationship to the trouble designation for each of the functions listed in above tables.

- (a) Select the SOG class of marker test, by operating the ORIG, SDR, OGT, MISC, or ITDO key, if provided, or set the TSTA or TSTB switch to the required position.
- (b) Select class of call and type of translation. On some types of master test control frames local translation is prewired and no key need be operated.
- (c) Select the particular CM which produced the record.
- (d) Digits A (0-9) through K (0-9) can be operated to simulate the called number registered on the trouble record card.
- (e) Set up the line location indicated by the trouble record card. (Used only on ORIG and SDR class of test.)
- (f) Operate the class-of-service key(s) or switch(es) as indicated on the trouble record card.
- (g) With the FS/NTFS key normal, the CM selects a trunk link frame in the same manner that it would on a service call. By operating the FS key along with the FG(0-2) key and an FS(0-9) key or the FS(0-9) switch, the CM selects a trunk link frame in the normal manner but is restricted to selecting only that trunk link frame corresponding to the operated FS(0-9) keys or switch. The NTFS key is intended for use when it is desirable to select a trunk which is maintenance busy. An operated NTFS key permits selection of a particular trunk link frame (under control of the FG(0-2) and FS(0-9) keys without first testing for idle trunks on that trunk link frame.

- (h) With the TS/NTTS key normal, the CM selects a trunk in the normal manner. With the TS key operated (along with the TSO-19 key or the TST1 key with TSU0-9 switch), the CM selects a trunk in the normal manner, but is restricted to selecting only that trunk corresponding to the operated TSO-19, or the setting of the TST1 key and TSU switch. With NTTS key operated, control of trunk selection by the marker is similar to TS key operated. However, in addition, the TST relay in the trunk link frame is operated. When the TST relay operates, all trunks which are made busy on the trunk link frame are restored to service (MB relay releases). It is, therefore, possible to select a particular trunk with TS(0-9) key operated, which is maintenance busy. The maintenance busy condition is removed only during the time that the marker (engaged on the test call) is connected to the trunk link frame.
- (i) If allotted trunk groups are furnished, the GPA or GPB key is operated. The marker will operate with the corresponding allotter group and will not advance from one to another.
- (j) Outgoing sender selection, if used, can be selected by operating SGA/SGB key for subgroup A or B, with OSS key operated. The SGA or SGB key operated directs the marker to connect to the A or B subgroup of senders respectively without first testing for an idle sender. The operated OS(0-4) key or switch allows the marker to select only the sender which corresponds to the operated key. The plug-busy condition is removed from all senders of the subgroup after the marker gains access to the subgroup.
- (k) A particular path through the network from a line in a particular horizontal group on a line link frame to a trunk on a particular trunk switch of a trunk link frame is defined by channel number and junctor group.
- (1) Operation of a CH(0-9) key or the CH(0-9) switch will direct the CM to select that channel number.
 - (2) Selection of a particular junctor group is not quite as straightforward. Reference should be made to the chart on SFD-C809 to select the horizontal line of the chart corresponding to the size of office. Note that the same junctor group may be selected in two or more junctor sequence positions and is dependent on junctor step position 1 or 2.

- (3) The JSQ(0-5) key or switch should be operated to select a junctor sequence position which associates with the junctor group for the junctor step selected. In some cases, the JSQ(0-5) key or switch might be set in any of several positions to select the desired junctor group.
- (l) With the TR2 key normal, a first trial call is simulated. Operating the TR2 key simulates a second trial call.
- (m) With the OBS key normal, a nonobserved call is simulated, and operating the key simulates an observed call.

C8-3 USE OF CLASS OF TEST TABLES

The class-of-test tables shown on SFD-C810 through C822 summarize, in tabular form, the key(s) and switches(es) used to establish a particular class of test. A single line is used to separate a particular function with its associated figure, option, key, or switch. The double line within the single lines is used to separate the various options on vintages of master test control frames. The note column and sheet notes are as follows:

- (a) Note 1 indicates that all key(s) or switch(es) must be operated to make a proper test frame setup for the particular class of test. It is suggested that known working equipment must be selected for test.
- (b) Note 2 indicates the key(s) or switch(es) to be used to simulate the trouble record. Refer to simulation tables in SFD-C802, C804, or C806 and their associated colored trouble record card on the opposite pages (C803, C805, or C807) of the simulated table selected. The tables and colored trouble record cards, along with the class of test tables, will assist the maintenance personnel in selecting the proper key(s) or switch(es) to be operated in order to properly simulate the reported trouble condition.
- (c) Note 3 indicates those key(s) or switch(es) used for additional marker tests but they are not necessarily required for trouble record test or simulation test.

C8-4 ORIGINATING CLASS OF MARKER TEST SFD-C810, C811

On an originating class of marker test, the MTC (master test control) circuit simulates an originating register. To perform this task, the master test frame is first primed with code and digits, originating line location, class of service, and other information which it would normally receive from an originating register. After receiving input information from the MTC, the marker proceeds to function in accordance with its translation of the information received to set up a connection.

The originating class of marker test can be used in different types of call arrangements which are listed below.

- (a) SOG - Establishes a path from the originating line location to an outgoing trunk with or without a sender attached (SFD-C810 and C811).
- (b) IAO - Establishes a path from the terminating line location to an intraoffice trunk (terminating stage) or from the originating line location to the intraoffice trunk, (originating stage) with sender attached if AMA is required.
- (c) IMG - Establishes a path from the originating line location to an intermarker group trunk with sender attached.
- (d) REV - Establishes a path from the originating line location to a reverting trunk (SFD-C812 and C813).

NOTE: The test arrangements for paragraphs (b) and (c) above will be described in maintenance sections of SCD-E and SCD-F respectively, in Issue 4.

C8-5 SENDER CLASS OF TEST, GENERAL DESCRIPTION

Tests of regular calls using outgoing senders, without AMA, are usually made using the originating test line as the calling line location. On this type of test the MTC (master test control) circuit extends the originating test line to the AMRST (automatic monitor, register and sender test) to simulate the calling customer action after the customer has dialed the number. The test connections are set up by the completing marker, under control of the MTC. The keys of the MTC are operated to select the marker used on this test, to set up the called number to be outpulsed by the sender, to set up the class of service of the calling line, to select the sender to be tested, and to select the outgoing trunk, if a trunk is required. A particular outgoing trunk may be used for the test by selecting a trunk that has access to the desired sender, and by operating the proper trunk selection keys.

The keys of the AMRST are operated to prepare the circuit for test, to select the sender group, and to establish certain test conditions to be applied to the sender as simulated trunk and trunk conductor conditions.

When the AMRST is ready for test, the MTC connects to the MTFC (master test frame connector) which seizes the selected marker. The MTC simulates an originating register which has received a dialed number from a calling customer. The marker, having received the required information, determines the route, selects the desired sender, and selects an outgoing trunk that has access to that particular sender. The marker then establishes a connection from the trunk link frame location of the trunk to the line link frame location of the originating test line. The marker selects and seizes the desired sender through the OSC (outsender connector) and OSL (outsender link) circuits and connects the sender to the outgoing trunk. The marker then passes the called number, along with class signals and other information, to the sender. The marker makes its usual checks and releases, leaving the connection held operated under control of the test circuit. With this connection, the test circuit simulates the calling customer and incoming trunk in the distant office. The sender makes the required test of trunk conductors and trunk conditions and then starts to pulse out the called number. The outgoing end of the trunk is connected to the monitor which receives and records the pulses from the sender. The monitor then matches the called number received from the sender against the called number received from the master test control circuit. If they match, an OK lamp lights on the monitor panel; if they do not match, the TBL lamp lights and a trouble recorder card is perforated.

C8-5.1 SENDER TEST, DP AND MF USING MASTER TEST CONTROL FRAME,
SFD-C814

On a sender class of test, the MTC connects to the monitor and after determining that the monitor is ready for a test, signals the monitor and proceeds to connect to a marker. The MTC directs the marker to set up a test connection to the originating test line. When the marker has completed setting up the connection, the marker gives a release signal to the MTC which releases the marker and connector, leaving the connection to the sender held up by the monitor.

C8-5.2 SENDER TEST, DP AND MF

The SFD-C814 and C815 summarize, in tabular form the keys and switches necessary to establish a sender class of test using the MTC. The keys listed are associated only with the MTC frame with the exception of MAC, STT, SG SEL(0-10) and SGT which are located on the AMRST frame and are necessary for proper sender selection.

The other AMRST keys required for testing other features and the manner in which the AMRST performs tests of the MF and DP senders will be covered in Section J of the SFD which covers test frame operation.

C8-6 REVERTING CLASS OF TEST (SFD-C812)

A reverting call is a call to a customer on the same line as the calling customer.

When a reverting call is required, a connection is established from the customers line through the LL and TL switches to:

- (a) a reverting trunk if charging is not required, or
- (b) an operator trunk if a reverting trunk is provided and charging is required

Since all customers on the same line have the same line link location, the marker makes the reverting test by matching the calling line link location against the called line link location, and if a match is made the call is handled as a reverting call.

When this type of call is simulated on the MTC (master test control) frame, a ring party line location is selected that does not require charging on an intraoffice route. Select the telephone number A- through G- associated with this line location and select class of service and rate treatment as required for access to selected route.

When the called number is received and translated, the office code causes the call to proceed as an ITR call with FLG linkage. However, when translation from the number group is received and recorded, an operate circuit in the marker for the RV1,2 relays is closed in the calling and called line location match circuit. This operates the RV1,2 relays which operate the RV relay, indicating a reverting type call. The marker will route advance to select a reverting trunk.

Sheet SFD-C812 summarizes, in a tabular form, the keys and switches necessary to test a reverting type call from the master test control frame.

C8-7 OGT CLASS OF TRUNK TEST SFD-C816 AND C817

The OGT class of trunk test is used for testing outgoing trunks which require senders, and for testing subscriber to trunk intermarker group trunks. The MTC (master test control) circuit connects to the trunk test circuit and signals it to prepare for a test of an outgoing trunk. The test circuit simulates an originating class of call and proceeds to connect to a marker which it directs to set up a connection from the originating test line, to the outgoing trunk to be tested. The marker is signaled to operate the TT relay in the trunk which gives the trunk test circuit access to the outgoing end of the trunk. An ND (no digits) signal is given to the sender to allow it to release without pulsing.

After the TT relay in the outgoing trunk circuit (or in the subscriber to trunk intermarker group trunk circuit) has operated, the TT relay connects the outgoing tip and ring, TO and RO, of the trunk circuit into a multiple which is extended to the trunk test circuit.

In the trunk test circuit, the OGT, TTK, ST relays, and the TLK key are operated. The originating end of the outgoing trunk circuit is held by the originating supervision circuit. The OGT relay connects the tip and ring of the outgoing trunk circuit to the simulated incoming trunk circuit consisting of relays A, IS, and T.

The OGT relay also connects the terminating side of the simulated trunk to the contacts of the ANS relay, so that when the ANS key is operated, the IS relay operates. The IS relay operates the T relay which in turn reverses battery supplied from the winding of A relay toward the CS relay in the outgoing trunk circuit. The operation of the CS relay is checked by lighting the OGT-CS lamp on the trunk test circuit panel.

The SFD-C816 and C817 summarize, in a tabular form, the keys and switches necessary to test an OGT type call from the master test control frame.

C8-8 MISC CLASS OF TRUNK TEST SFD-C818 AND C819

The MISC class of trunk test is primarily designed for testing miscellaneous types of trunks that are not furnished with TT relays but are selected by marker route relays. The MISC class of test is also used to test regular types of outgoing trunk circuits when the TT relays are not operated.

The MTC connects to the trunk test circuit, signals the trunk test circuit to prepare for miscellaneous class of test, and after receiving a signal that the trunk test circuit is normal, grounds its start lead and proceeds to connect to a marker (which, in turn, is directed to set up a connection from the originating test line to the trunk to be tested.)

The test circuit functions as described for OGT class of test except the marker does not operate the TT relay in outgoing trunks, nor does it give an ND signal to senders. The connection is completed to a terminating office as directed by the dialed digits and class of service given to the marker.

A number of miscellaneous trunks may be tested with MISC class. These trunks are similar to outgoing trunks in that they have route relay assignments. They differ, however, in that they do not have TT relays. The trunks generally used in this class are:

- (a) Recording Completing Special Service or Vacant Code Trunk Circuit
- (b) Tone or Partial Dial Trunk Circuit
- (c) Trunk to Test Desk
- (d) Repair or Information Trunk Circuit
- (e) Permanent Signal Holding Trunk Circuit
- (f) Common Overflow Trunk Circuit
- (g) Revertive Ringing Trunk Circuit
- (h) Station Ringer Test Circuit
- (i) Stuck Coin Trunk Circuit

The originating test line is connected to the trunk circuit under test using a regular channel. The originating supervision, coin, originating sleeve supervision, ringing bridge, dialing, and talking circuits can be used in testing the miscellaneous trunk circuits.

No detailed procedure will be provided in this SCD for testing the miscellaneous trunk circuits because most of the required tests are obvious. However, some of the unusual features will be discussed.

In testing noncoin recording completing trunks, the PK lamp should not light until the attendant answers. The attendant should be able to bring in the R- lamp by ringing back on the connection with the TLK key operated. In testing coin recording completing trunks, the attendant should be able to provide coin collect and return pulses to the trunk test circuit.

Associated with permanent signal holding trunks, tests can be made of the permanent signal concentrating circuit features such as ringing, coin control, and howler application. The permanent signal holding circuit has a timeout feature which causes the associated line lamp at the test frame to change from a steadily lighted condition to a flashing condition. The timeout can be speeded up by operating key PS1/PS2 first to position PS1 and then to position PS2.

In testing revertive ringing trunk circuits, the RVC key should be operated to connect the gas tube ringing detection circuit to the originating tip and ring so that ringing can be checked.

When testing MISC class of test on regular outgoing trunks or on other types of miscellaneous trunks it is always advisable to use the BSP sections for proper key and lamp operations for any trunk circuit being tested.

The SFD-C818 and C819 summarize in a tabular form the keys and switches necessary to test a MISC type call from the master test control frame.

C8-9 ITDO CLASS OF TRUNK TEST SFD-C820 AND C821

The ITDO class of trunk test is used for testing certain features of incoming trunks in distant offices. The master test control circuit connects to the trunk test circuit and signals it to prepare for a test of an incoming trunk in a distant office. The test circuit directs a marker to set up a connection from the originating test line to an outgoing trunk. This outgoing trunk must be connected to an incoming trunk in the distant office which is to be tested. The TT relay of the outgoing trunk circuit is operated to give the trunk test circuit access to the outgoing end of the outgoing trunk over the tip and ring to the distant incoming trunk. The selected sender is primed with information the incoming trunk uses to establish connection in the distant office. Pulses from the sender direct the setting up of the connection in the distant office to the called line.

The marker operates the TT relay in the outgoing trunk circuit when the ITDO class of trunk test is performed. The ST, ITDO, and TT relays operate in the trunk test circuit. It is assumed that the TLK key is operated prior to the tests. The TT relay in the operated outgoing trunk circuit connects the trunk circuits outgoing tip and ring leads, TO and RO, through front (make) contacts of the ITDO relay and connects the A and B resistors to the trunk conductors tip and ring, T1 and R1 leads, respectively. In other words, the A and B resistors are inserted in series with the outgoing loop. The ITDO relay also connects the front contact of the CS relay of the outgoing trunk circuit to the OCT-CS lamp.

The completing marker in the distant office is directed to set up a call to an incoming trunk test line. This test line trips ringing and sends flashing supervision and tones back to the originating office. The OCT-CS lamp located in the originating office should follow the flashing supervision. This flashing supervision is of such a nature that it should not cause charge conditions to be set up in the outgoing trunk circuits.

Although this class of test is primarily for testing the trunk circuits in the distant office, noncharge features of the outgoing trunk circuit are tested as a by-product. For this reason, the tests may be made simulating flat rate, AMA, coin, or message rate calls.

The SFD-C820 and C821 summarize, in a tabular form, the keys and switches necessary to test an ITDO type call from the master test control frame.

C8-10 TEST CALL SET UP FOR TRUNK TRANSMISSION SFD-C823, C824, AND C825

Trunk circuits are tested to a precision transmission test line using MISC class of test. If an intraoffice trunk circuit is involved, the call is directed to a transmission test line which trips ringing and supplies a signal of standard level milliwatt supply which is measured by the transmission measuring set connected to the test termination circuit that is part of the master test frame, jack, lamp, and key circuit.

If an outgoing trunk is involved and the MISC class of test is used, the TT relay of the outgoing trunk circuit will not be operated. The call is directed to a transmission test line located in the distant office. This transmission test line will automatically trip ringing and connect the trunk to a transmission test line with milliwatt supply.

C8-10.1 ONE WAY TRANSMISSION TESTS

Transmission tests to local offices on 2-wire trunks that are either nonrepeaters or use E- type repeaters are tested from the master test control frame using MISC class of test. These types of trunks are referred to as one-way transmission measurements. The TM1 jack of the master test frame jack, lamp, and key circuit is patched to the test termination circuit. A transmission measuring set is connected to the test terminating circuit. Operation of the master test control circuit start key initiates a connection to the distant office transmission test line. When the connection is established, 1000-cycle tone will be heard in the master test frame telephone set. To measure the loss on the circuit, a test key in the test termination circuit is operated and a transmission measuring set is connected to the REC1 jack. The TM1 key associated with the TM1 jack of the master test frame jack, lamp, and key circuit is operated which cuts off the master test frame telephone circuit and cuts through the trunk test circuits tip and ring to the measuring test set. The 1000-cycle tone can now be measured on a far-to-near (F-N) basis.

C8-10.2 TWO WAY TRANSMISSION TESTS

Transmission tests to local offices, on trunks which operate with carriers of 4-wire facilities, are tested from the master test control frame using MISC class of test. These types of trunks are referred to as 2-way transmission measurements, performed on a loop-around type of test. Trunks of this type, which may have different losses in the two directions of transmission, are tested in two steps.

Step 1 consists of making a far-to-near (F-N) transmission test as described in paragraph C8-10.1.

Patch cords are arranged to connect the TM1 and TM2 jacks to the auxiliary jack (TRK2) and the regular jack (TRK1) respectively of the test termination circuit. The measuring set is connected to the auxiliary jack (REC2) of the test termination circuit and the milliwatt supply is connected to the regular jack (SD) of the test termination circuit.

A connection is established to the first loop-around test line at the distant office via a reference trunk (1st APP). Test keys are operated in the auxiliary termination circuit and the master test frame jack, lamp, and key circuit to cut through the transmission path and return ground via the sleeve of the TM1 jack to operate relay TM1 in the trunk test circuit. Relay TM1 transfers the telephone circuit to the tip and ring of the originating test line and grounds the TM1 lead to the master test control circuit for use in Step 2 of the tests. The connection is held from the auxiliary termination circuit independent of the master test control circuit which is then released. The trunk to be tested (2nd APP) and the second loop-around test line number are then selected at the master test control circuit.

Step 2 is initiated by operation of the control start key. Ground on lead TM1 causes the control circuit to change marker priming information pertaining to the calling line location to that of the combined originating and terminating test line. A connection is, therefore, established from the telephone circuit via the combined test line to the second loop around test line location at the remote office.

Operation of test keys in the test termination circuit will now cut through the milliwatt supply transmission path and extend ground via the TM2 jack to operate relay TM2. Relay TM2 cuts off the telephone circuit and cuts through the tip and ring from the test termination circuit to the combined test line.

The loss, as measured in Step 2, is the sum of the F-N loss of trunk (1st APP) and the N-F loss of trunk (2nd APP). Subtracting the loss measured in Step 1 now gives the value of the N-F loss for trunk (2nd APP).